THE

INTERNATIONAL SUGAR JOURNAL

WITH WHICH IS INCORPORATED

THE SUGAR CANE,

(1869-1898,)

A MONTHLY MAGAZINE,

DEVOTED TO THE INTERESTS OF THE SUGAR INDUSTRY GENERALLY.

JANUARY TO DECEMBER,

1911.

VOLUME XIII.

ALTRINCHAM:
"INTERNATIONAL SUGAR JOURNAL" OFFICE.
1911

INDEX TO VOLUME XIII.

[(*P*) implies *Paragraph.*]

ABSTRACTS.

Subject Matter.

Names.

PATENTS.

Names.

Subject Matter.

THE INTERNATIONAL SUGAR JOURNAL.

No. 145. JANUARY, 1911. Vol. XIII.

☞ All communications to be addressed to the Editor, Office of "The Sugar Cane," Altrincham, near Manchester. All Advertisements to be sent direct.

☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

Cheques and Postal Orders to be made payable to NORMAN RODGER, Altrincham.

The Editor will be glad to consider any MSS. sent to him for insertion in this Journal and will endeavour to return the same if unsuitable; but he cannot undertake to be responsible for them unless a stamped addressed envelope is enclosed.

NOTES AND COMMENTS.

Communication with the West Indies.

The British West Indies have been on the verge of a calamity, owing to the termination of the old mail contract with the Royal Mail Steam Packet Co., and the prolonged failure to complete a new one. The last boat under the old agreement sailed the other day and negotiations extending over several months had failed to come to any arrangement, satisfactory to all parties. The main difficulty was the cost. It therefore looked as though the troubles of 1905 were to be repeated, when communication between the United Kingdom and the West Indies was only maintained by roundabout and irregular mails. But very fortunately news comes at the eleventh hour of the conclusion of a new contract for seven years, and a critical situation is saved.

The new contract is based on the payment of an annual subsidy of £63,000 to the steamship line. By contributing £20,000 of that sum, Trinidad becomes the West Indian headquarters, where transshipment to the Intercolonial steamers will take place. British Guiana pays £3,000 in addition to her Intercolonial contribution. Jamaica is not included in the arrangement, the mails there being paid for on a poundage basis. The old contract, just expired, was likewise on a poundage basis; but the contract terminating in 1905 was based on a subsidy of £85,000, so that the new contract will, therefore, be very considerably cheaper than was the last one of its type.

The West Indies are to be congratulated on the success of the negotiations conducted by the Imperial Government that have produced this result. It would have been deplorable if they had been cut off from direct communication with the mother country, and we are glad to see that the many protests that have been sent to the Colonial Secretary from the various islands have to all appearance had due effect, and the gloomy outlook has been dispelled. There are numerous considerations, Imperial, sentimental and material, that ought to exceed in importance all considerations of mere cost; and just now when these colonies are returning to something of their former prosperity any parsimonious treatment on the part of the Home Government would be bound to affect them disastrously.

The Cost of Production.

In our last issue we gave prominence to a lucid article from the pen of Mr. George Martineau, C.B., on "The Cost of Production" in which he quoted authorities to show what the cost of sugar was in some of the principal centres of the world. Cuba, Java, and Hawaii are generally considered to lead the way in economical production of cane sugar; and, as regards Cuba, Messrs. Willett & Gray's pronouncement that 8s. 6d. f.o.b. is the average figure must be taken as final. As regards Java, however, there was room for a fresh statement, and Mr. H. C. Prinsen Geerligs, at Mr. Martineau's suggestion, now supplies it. He shows that the cost of production of Java sugar has not decreased of late years and may be put down at 7s. 6½d. per cwt., f.o.b. Java. With a rate of 1s. for freight to Europe added, we arrive at the figure of 8s. 6½d. as the average cost per cwt. of Java sugar delivered in Europe. When we compare this with the price of 88 per cent. beet in May, 1902, which stood at 5s. 10½d., it disposes once for all of the fond argument of the opponents of the Brussels Convention, that not even the working of the Cartels could have produced any monopoly in the sugar market, as the supply of cane sugar from Java and Cuba would always have been sufficient to counteract the machinations of German and Austrian fabricants. It is now clear that had the Cartels been prolonged, the sugar industry of both Java and Cuba would have been most adversely affected by the continued low prices of sugar, and the dependence of the world's supply on beet sugar production would have been almost complete. Mr. Geerligs has surely driven another nail into the coffin of the Anti-conventionists; and, for our part, we consider that receptacle is quite ready for interment.

The Hawaiian Sugar Crops, 1906-1910.

The record of the Hawaiian sugar crops for the past five years for the period October to September inclusive is shown by the following figures of short tons (2000 lbs.):—

	1906.	1907.	1908.	1909.	1910.
Hawaii ..	137,750	143,891	180,159	172,341	159,856
Maui ..	102,960	104,772	122,629	134,605	139,454
Oahu ..	113,750	119,273	137,013	138,423	128,648
Kauai..	74,753	72,081	81,322	89,787	90,169
Total ..	429,213	440,017	521,123	535,156	518,127

A Lectureship in Sugar at Glasgow.

As will be seen from a perusal of our advertising pages, the Governors of the Glasgow and West of Scotland Technical College have decided to institute a course of instruction in Sugar Manufacture under the direction of a specialist who has had practical experience of the manufacture of cane sugar, to date from September next. This lecturer will be responsible for the classes in his subject, but will be under the general supervision of the Professor of Technical Chemistry. The appointment is to be for five years at least, and a minimum salary of £250 has been guaranteed. The lecturer will be required to place his whole time at the disposal of the Governors, but this condition will not preclude him from the acceptance of private engagements which, in the opinion of the Governors, will not interfere with the performance of his duties. We have every reason for believing that the duties will be by no means onerous, at any rate to start with, and a man of practical experience should have enough time and opportunity at his disposal to add appreciably to the above somewhat moderate income by means of some consulting practice. It is therefore a post that should attract a good man, and we hope such a one will be secured.

Dividends.

The close of the year brings with it a crop of dividend announcements. Amongst them we may cite that of Messrs Henry Tate & Sons Ltd., who come out very well with a dividend of 17 per cent. on the ordinary shares, placing £10,000 to reserve and carrying £12,016 forward. The East India Distilleries and Sugar Factories, Ld., after paying Debenture interest and providing for the redemption of debenture stock, show a profit of £15,871. The Directors proposed a dividend of 5 per cent. on the preference shares, and carried forward £2,340. The Cuban American Sugar Company made a gross profit for the year, ending September 30th last, of $2,846,431, of which $1,777,182 ranked as net profit. After paying dividends on the preferred stock and setting aside a sum for sinking fund purposes, $2,227,789 has been carried forward. On the other hand the shareholders of the Great Say Refineries of Paris have again to go without a dividend, what profit has been made being held over pending some litigation arising out of the Paris floods of last year. The Company

have not done badly, having increased their profits from 3,687,300 frs. to 5,006,560 frs. but of this, 3 million frs. has been written off for depreciation. Finally, we have the report of the Colonial Sugar Refining Co., of Australia, which had available for dividend the sum of £312,685. A dividend of 10 per cent. was declared and £170,185 carried forward.

SEVEN YEARS OF THE SUGAR CONVENTION.

To look back at the thirty years of struggle against the dogmatic *non possumus* of the so-called Free Traders, with all its interesting and instructive episodes, and now to contemplate the truly remarkable results of our final victory, is a lesson in practical Political Economy well worth learning—and even paying for. Mr. Hinckes has had the pleasure of writing this second retrospect, and has done it in every way well.* In twenty-four pages of good scholarly and clearly expressed language he puts the matter forcibly before his readers. Every word must carry conviction to the mind of the enquiring Englishman who wants to know what all this fuss about "the Sugar Bounties" really meant. There are thirty pages more, where the writer ventures upon wider ground, but it is enough at present to glance at the purely "Sugar Bounty" portion of the book, which should be read by all who desire to know something about a very important incident both in the Economic and the Political world. Even statesmen would do well to get this valuable pamphlet, because the subject is not yet settled and done with. Cabinet Ministers are not celebrated for a burning desire to "master a subject;" some people, who ought to know, even go so far as to say that that is the very last thing they would think of doing. Here are twenty-four small pages of good print which will enable them to do so, and will also teach them a good deal which they ought to know if they are to tackle, with knowledge and intelligence the difficult question of unfair foreign competition.

The importance of the subject is forcibly expressed by Mr. Hinckes at the outset, when he declares that "time has justified what may be rightly called the most important international treaty for the limitation and regulation of *fiscal armaments* ever enforced." The career of the European beetroot sugar industry has indeed been an attack upon our industries as palpable and violent as if the armaments had been material instead of fiscal. Equally true and forcible are the writer's words when he points out how few there are who realise that we are

---

* SEVEN YEARS OF THE SUGAR CONVENTION 1903-1910. A vindication of Mr. Chamberlain's Imperial and Commercial Policy. By Ralph T. Hinckes (M.A.Ch.Ch., Oxon.) P. S. King & Sons, 1910. Price threepence.

now parties to an international agreement by means of which State-aided competition, tariff wars, and dumping have been rendered impossible. The only necessary modification of this declaration is with regard to the word impossible. This was, no doubt, the intention of the Conference, but it must be admitted—as was urged by some at the time—that the reduction of the surtax to 6 francs per 100 kilogrammes was not quite sufficient. Half that surtax should be enough to give the European industries a monopoly in their own markets, and the recent revival of the Austrian cartel, with the consequent rise in the value of refined sugar in that country above the level of the world's price, shows that the reduced surtax is still sufficient, in skilful hands, to give rise to a small cartel bounty. If this continues it must be remedied by a further reduction in the amount of the legal surtax.

The struggle against false Free Trade and in favour of the genuine article is touched with a light hand in passing. It was, and still is, a curious spectacle to see honest men, who imagine that the doctrine—"Duty for revenue purposes only"—embraces the whole principle of Free Trade, any departure from which is rank heresy, trying to grapple with the case of State-aided foreign competition on that erroneous basis. If the controversy had been confined to the purely scientific aspect of the question we should have arrived at a definite solution of the problem without much waste of time. Unfortunately it became a party question, so the honest men ceased to count. "Free Trade" was considered to be a good cry, and capital was to be made out of it by opposing any system of defence against this flagrant attack upon honest industry. In vain did men of economic science urge that "a duty to countervail a bounty is not only consistent with Free Trade but positively conceived in the interests of Free Trade." The champions of a spurious Free Trade found their cry a good one, it brought credit to the party and was eagerly listened to by the ignorant crowd. It was only at the end of thirty years of fruitless struggle that Mr. Chamberlain came forward and stamped out the false prophets.

The effect of the bounty-aided production of beetroot sugar in discouraging the natural producer is well indicated. It is not so much that it actually reduced natural production, but that it prevented the natural producer from enjoying his fair share in the growing consumption of the world. Hence the beetroot industry progressed from year to year nearer to the goal of monopoly. That was the danger and we nearly reached it in 1900-1902.

Mr. Hinckes deals tenderly with the Government's diplomacy of 1908. It was, in point of fact, a gross breach of faith. The foreign Governments had abolished their bounties on the strength of the solemn undertaking given to them by Great Britain, in 1902, that

bounty-fed sugar should never be permitted to come into competition with them on British markets. In 1908 the British Government deliberately repudiated this essential condition of the contract. They covered their disgraceful retreat by much vague talk about restriction of imports and the raising of prices to the consumer. Never was there a more absolutely unfounded pretension. The world annually produces and consumes about 14,000,000 tons of sugar. Russia, the only offender, sent us on the average 40,000 tons a year. The British consumer, therefore, had 13,960,000 tons of sugar from which to select his small requirements of 1,600,000 tons. There never was a more comical reason for a gross departure from diplomatic honesty. But it went down with the ignorant crowd and very likely added to the reputation of the Government as the sole "bulwarks of Free Trade."

Mr. Hinckes then proceeds to the main subject of his essay, "the effect of the Convention on the sources of supply, prices, the workman's weekly budget, and the industries dependent on sugar." We cordially recommend this portion of his valuable pamphlet to the serious consideration of all readers, whether they be statesmen, politicians, economists, or only the rank and file of our sugar industries and their offshoots.

Mr. Hinckes gives us towards the end a well expressed *résumé* of the real pith of the whole matter. Here it is:—

> "It may be said that there is in every industry at any particular period 'a live and let live price,' being the lowest price at which the majority of producers can afford to sell, in other words, the lowest price at which the consumer can expect to buy. Any continued or substantial fall below such a price, or even, as in this case, any well-based uncertainty for the maintenance of such a price, by causing a diminished production, immediately reacts on the consumer. Nor is it necessarily those who cannot, from natural causes, produce most economically who go to the wall—in this case it was exactly the reverse.
>
> "The nation whose policy is directed to buy cheap by means of dumped products is in fact in pursuit of a will-o'-the-wisp!"

These words should be pondered by our friends the so-called free traders; but we fear that pondering is not one of their habits of work. Thinking out a subject is not within their plan of operations, they prefer the flash light of the instantaneous photograph.

The following figures of the quantity of sugar melted annually by the Greenock refiners give remarkable support to Mr. Hinckes's contention that the Sugar Convention has benefited the British refiner:—

MELTINGS BY THE CLYDE REFINERS.

	Tons.
Average of four years, 1897-1900	124,874
1901	139,383
1902	123,395
1903	120,560
Average of the seven years before the Convention	127,053
1904	151,820
1905	143,651
1906	188,390
1907	161,400
1908	173,315
1909	193,355
1910	213,100
Average for the seven years since the Convention	175,035

Increase 37·8 per cent.

GEORGE MARTINEAU.

COST OF PRODUCTION OF JAVA SUGAR.

By H. C. PRINSEN GEERLIGS.

As a complement to Mr. George Martineau's interesting paper on the cost of production of sugar, published in the December issue of this *Journal*, I give here some figures on the cost of production of Java sugar during the last years.

In the issue of July, 1904, of this *Journal* (p. 341), I set down the cost of production in the year 1902 of an average of 42 well-equipped factories at £7 5s. 11½d. per metric ton, subdivided as follows :—

	£	s.	d.		£	s.	d.
Salaries	0	13	4	Commission	0	7	2½
Cultivation	2	13	4	Sundry Expenses	0	4	6½
Transport of Cane	0	16	0	Wear and Tear	0	8	6½
Fuel	0	1	1½	New Machinery	0	15	9
Wages	0	3	9	Interest on floating Capital	0	8	0
Sundries	0	1	10½				
Packing	0	4	3		£7	5	11½
Transport of Sugar	0	8	3				

After calculating the cost of production of a great number of Java factories during the years 1908 and 1909, I found this figure to hold still good. The production of sugar to the acre has increased, but the price of many articles and the rate of wages have followed the same upward movement, so that on the whole the cost price of raw Java refining crystals, basis 96, packed in bags or baskets, delivered

at the buyers' doors at the ports, and including all charges of management, agriculture, transport of cane, machinery, manufacture, carriage to the coast, upkeep and depreciation of plant and buildings, but not including interest on the capital invested in the sugar house and machinery, may be put down at 5·50 guilders per picul of 61·76 kilos., or 7s. 6½d. per cwt.

At a rate for freight from Java to the United Kingdom or to the United States of 20s. per ton, this figure comes to 8s. 6½d. in Great Britain, or $1\frac{13}{16}$ cent. per pound in New York, and at a rate for freight of 25s. to the equivalent of 8s. 9½d. in England, or $1\frac{7}{8}$ cent. in America.

We therefore fully agree with Messrs. Willett & Gray when they state that the cost price of Java sugar is higher than 6s. per cwt. Some factories, situated in very favourable spots, may make the sugar at that price, but this is an exception and not a rule, and the average cost price is much higher, so that it may be taken at 7s. 6½d. per cwt. delivered at the buyers' warehouse on the coast.

SUGAR REFINING IN GREENOCK DURING 1910.

The *Greenock Telegraph* in giving its annual review of the local sugar refining industry for 1910, states that "the increase, observed in recent years, in the quantity of sugar worked in the Greenock sugar refineries has continued to make progress during the year now drawing to a close. The meltings will reach the satisfactory figure of about 214,000 tons for 1910, which compares with about 193,000 tons for 1909, showing an increase of about 11 per cent. This is the first time since 1890 that the figure of 200,000 tons has been exceeded, and gives a hopeful indication that the record out-turn of 1888 (249,000 tons) may be equalled within the course of a few years." The supplies have come in from a much wider area. Indeed the influence on prices caused by the unexpected shortage in the supply of beet sugar was not of any lasting character owing to the abundant supplies of cane sugar which were poured into the United Kingdom from all parts of the world—Java, Cuba, Mexico, Peru, the British West Indies, St. Croix, Mozambique, and Brazil all participating in the deliveries. "Had we been dependent" says the Review, "mainly on beetroot sugar, as we should almost certainly have been had the bounty-giving policy of European nations continued, the actual rise that occurred would have been nothing to the advance that would have taken place. But, thanks to the Brussels Convention which abolished the bounties, the cane sugar producers of the world have had the chief obstacle to the expansion of their business removed, and they have been enabled to produce crops under natural conditions of competition, and are very well able to hold their own against eetroot

sugar, ensuring to the sugar refining industry an ample supply of its raw material."

As to prices ruling during the year, the price of the standard mark of white crystals known as "Neill's Tops," duty paid, varied from a maximum of 19s. 10½d. touched early in May to a minimum of 14s. reached about Christmas. The number of refineries at work has remained the same; but those in existence have been kept continuously working excepting for one or two short stoppages for repairs.

The writer of the Review speculates on the possibility of the sugar tax being removed *in toto* in the next Budget. As far as the sugar refiners are concerned, it is of little consequence to them whether the change is made or not, save that in the abolition of the duties there would disappear a large amount of clerical work, and restrictions and expense entailed by the Customs supervision, for which inconveniences and charges the law makes the refiners no compensatory allowance such as distillers enjoy.

Dealing with the hopes for the expansion of the trade our contemporary declares that "the export of Greenock refined sugar does not make so much progress as one could wish considering the expanding output of our refineries. There is a certain inconsiderable quantity sent from Greenock to the Canadian market, which fact gives rise to complaints on the part of the Canadian sugar refiners in the evidence presented by them to the recent Commission which investigated the conditions of trade between Canada and the British West Indies. The Canadian refiners appear to be under the influence of the not unnatural, although somewhat selfish, desire that the whole Canadian market in refined sugar should be reserved for themselves, regardless of the interests of the Canadian consumers of sugar, who naturally would be benefited by the wholesome competition of supplies which might be imported from Britain. But, surely, if the Canadian refiners have the protection of the double freight borne by the British refined article, first, from the West Indies to Greenock, and, after refining, from Greenock to Canada, compared with the one freight for the shorter voyage from the West Indies to Halifax or Montreal, they need not fear any otherwise equal competition. The Canadian refiners appear also to be labouring under the delusion that the Greenock refiners can buy sugar in the West Indies at substantially lower prices than they themselves have to pay. This is quite a fallacy; the Greenock refiners have not yet come across any sellers of sugar, anywhere, who will accept anything less from them than Canadian or other buyers are prepared to give. It is to be hoped that we shall see, in the years to come, a substantial increase in the export of Greenock refined sugar to Canada, as well as to other quarters, where it has already obtained a footing, and also to other markets as yet untried."

THE SUGAR BEET.*

Its Mode of Cultivation and Development.

By Ed. Koppeschaar.

(Continued from page 614.)

II.—*(Concluded.)*

To describe further in all its details this comprehensive system of seed selection would far exceed the scope of these articles; but certain facts which it is of great importance to know, as well as one or two points of special interest, may fitly be introduced in these pages.

In the first place we must remark that in addition to the two improvements in the selection methods already described earlier in this chapter, *viz.*, *family selection* and *the splitting up of roots*, there is a third which deserves mention, and that is the *isolation of the seed-bearers.* When the selection beets are planted out in the field for obtaining seed from the family heads, they are grouped together in such a way that those individuals nearest related to each other are planted in the same group, thereby avoiding the cross-fertilization of individuals differing widely in character and quality. In the case of the production of commercial seed an isolation as great as 300 ft. is not considered too much.

The beet seed is thrashed out in a more or less moist condition, the drum of the thrashing machine being run at a rapid pace. The seed is then dried, cleaned, and sorted by machinery. The seed itself gets no warmer than 40° C. (104° F.) The "thinlings" are planted out triangular fashion, the distance from corner to corner for the three being 2 ft. to 2 ft. 3 in. A good crop will yield 2200 lbs. of seed per acre, a bumper crop as much as 2700 lbs.

In dealing with the principal factors that enter into the sale of seed, we must turn to what is now ancient history, and consider the various ways in which farmers used to make their contracts with the factories, when the latter were protected by their respective Governments. Before the Brussels Convention came into force, the fabricants (manufacturers) all received a bonus from the State based in some way or other on maximum extraction of sugar from the beet; this was originally meant as a measure of support to the rising industry as well as an inducement to keep up the contest with cane sugar. It is obvious that these fabricants had everything to gain by working up beets very rich in sugar. The older method of selection did conduce to obtaining this result, but it did not produce any great weight per acre, thus there was no favourable maximum of yield and percentage combined. Although the fabricant supplied the seed gratis,

and the farmer was bound down by contract to sow it, yet as long as he sold his beets to the factory irrespective of sugar richness and only by the gross weight of the roots, his interests were diagonally opposed to those of the manufacturer. The farmer made a profit if his yield to the acre was large; whether the sugar percentage was great or small did not trouble him. Thus it even happened that he went so far as to throw away the seed the factory provided him with and sowed seed of his own because it would yield a heavier crop of roots. Thereupon the manufacturer retorted by mixing his seed with a proportion of red mangel so as to expose the subterfuge. Such a strained situation was a natural result of the lack of a spirit of co-operation, and the dependence of the growers on monetary advances.

But when the greater part of the fiscal protection was rescinded and more assistance was forthcoming—such as agricultural education given by State teachers—and a system of co-operation was evolved, the farmers tended more and more to complete contracts based on the percentage of sugar in the roots, and factories began to spring up run on co-operative lines; so that the conditions entirely changed, and the seed most in demand was now that which would produce a beet rich in sugar (though not of the highest) and give a fair but not abnormal yield. This ensured a reasonable yield of sugar per acre while avoiding too great a bulk of roots to be worked up; it also restricted the amount of plant food, fertilizer, &c., required to the acre. It may be remembered that mangels give the highest yield of sugar per acre, but absorb a commensurate amount of plant food and represent a tremendous bulk to handle.

To sum up, the system of family selection has produced beets that have a fairly high percentage of sugar combined with a fair yield per acre. And keeping these processes of evolution in mind, the farmers will be able to make their choice of what the market offers, whether they be guided by their own yields or by carefully conducted experimental plots.

Though we have written at some length on this subject of beet seed, we have not so far pointed out that the beet seed is properly speaking known as seed balls. Thanks to the courtesy of Messrs. Kuhn & Co. we were able in our last issue to reproduce a sketch of these balls, which shows the position of the real seeds, enclosed in a rather hard woody tissue as a means of protection. Each ball contains from three to five seeds.*

If we now assume that we have given due attention to our choice of beet seed as regards its internal qualities (including a consideration of the question whether the roots are to be harvested early or late,

* In pursuance of what has already been written on the subject of weeding out the seedlings when the plants have sprouted in a row, the writer cannot feel enthusiastic at the trials undertaken by the United States' Department of Agriculture to produce single-seeded balls, however great an admirer of their work he may otherwise be.

since, as a campaign lasts only 70 to 80 days, we should when planting large tracts influence the time of harvest by choice of early or late strains of seed, soil and manuring) we can proceed to an examination of the external qualities, germination, &c.

Probably on account of the centralized system of distributing the seed, the great issues that depend on it and the impossibility for the sugar factory management to judge such enormous quantities of seed, special rules and instructions (on which a whole chapter could be written) have been drawn up in order to assure the buyer that he gets what he pays for. But, of course, sound, healthy beet seed has to fulfil just the same conditions as other seed, which may be summed up as follows:—

The seed should be well filled, not necessarily the heaviest, but full grown; in shrunken, half-grown seeds, the germ is either weak or lacks the requisite nutriment to germinate rapidly and well. The bushel weight is a fair measure taking into account the relative ball weight. Well grown seed should weigh about 25 to 27 kg. per hectolitre (20 to 22 lbs. per bushel). The seed should be unbroken and of a good colour; its odour should be suggestive of freshness. And it is of very great importance that the seeds should germinate quickly—within a few days in fact. But as a rule good seed contains very few balls that refuse to germinate.

Badly ripened or old seed will have less energy and therefore germinate slower, while a larger proportion of such seed will fail to germinate at all, owing to want of germinative power. Apart from that, the germ may have been damaged either by mechanical means or by fungi, moisture, &c. When prepared and scaled seed is bought, it should be carefully tested; it is, however, wisest to buy the seed in its natural covering. As to fungi, a well drained soil should prevent its growth, so that there is no real need to resort to special fungus-destroying preparations to treat healthy seed with. But while the high standing of the grower should be some guarantee that the buyer gets sound seed, it is advisable at times to test the seed as to its germinative energy and power. The test only requires a common soup plate with a glass cover and some sand kept moist and the whole placed where an even temperature of about 70° can be had, *e.g.*, in a stable. The balls are soaked in water for a day, and then laid out in hollows moulded into the moist (but not wet) sand by means of a round platten of wood studded with nails. The young shoots are taken out when they are about an inch high.

Of course, the seed should contain as few impurities as possible. Harmful ones include weed seeds, harmless ones clay balls, straw, &c.

Some figures relative to beet seed may follow here. Taking the percentages as *minimum* values, it is, we think, safe to draw therefrom conclusions on the value of the seed provided the sample was sound and the analysis carried out by reliable persons.

1. 1 kg. of beet seed (2·2 lbs.) should give at least 70,000 seedlings within 14 days.

2. Of this number at least 46,000 should be forced up *within the first six days.*

3. Out of 100 seed balls, at least 75 will readily germinate.

4. Beet seed should not possess more that 15 per cent. moisture. An analytical test for water will reveal this exactly; but seed containing an excess of water will not smell fresh on arriving at its destination. The importance of this is no small one. Too much moisture, besides being paid for, will cause fungous germs to get a foothold while the whole mass of seed is liable to develop too high a temperature, and thereby destroy the germinating power.

5. Impurities should not exceed 3 per cent.

These data represent the normal standard, and any decent beet seed should easily attain to these requirements. But it has to be born in mind that in years where the seed crop has from some reason or other been smaller than usual sellers will try to keep below the limits of these standards, and a certain amount of sampling will be advisable. Those who have not an accurate balance at their disposal, will find the following test as to germinative power and energy of some service. Within 14 days there should be driven out from 100 sound seed balls at least 150 well developed shoots. Of these 150, at least 135 should appear within the first 6 days.

III.

Atavism.

The original Silesian white beet from which the present stock is derived had wild-growing ancestors. Certain conditions may lead to atavism to these, involving more or less loss to the grower.

If we state that the white Silesian beet formed the stock from which Vilmorin and his successors derived their material for selection purposes, we shall only be going backward about half a century. Further back than that, we at least know for certain that at the beginning of the nineteenth century several species of the *Beta* family existed. Whence they all came we do not know. The Romans were probably acquainted with only two kinds, which were used as vegetables; whether they were wild or cultivated is not known.

If we accept Professor de Vries' statement that *Beta vulgaris* and *Beta maritima* were the main ancestors, the one being an annual the other a biennial plant, we have an explanation of the fact that in almost every beet field a certain percentage of the beets form a stem and bear flowers and seed in their first year. We can safely assume that both biennial and annual plants originated from perennial ones. First were derived the biennial plants, and finally out of these came the annual ones. Consequently in this case biennial plants sown

from the seed of annuals would be atavistic, and those plants called "defiers" * would show atavism to the perennial ancestor.

As a matter of fact selection has not yet been able to eliminate the "shooters" from the beet fields, notwithstanding in every generation biennial individuals are selected for seed bearers. We may therefore safely conclude that no variety of beet is purely annual or biennial, but comprises both kinds. From the seed of either of these types both types may be begotten. The percentage of annuals depends on variety, culture and selection, selection in this case meaning the choice of the mother plant and judging the seed bearers from the quality of their offspring.

By selecting for seed bearers those plants from whose seed only few annuals come, and by repeating this, the variety may be improved in that respect. Furthermore, experience has proved that any set-back in the germination period or while the young seedling is shooting up, favours the growth of so-called "shooters," *e.g.*, night frost will favour it. We must suppose that the night frost, while giving a set-back, acts as a stimulus in the same way as the Winter does in the case of a biennial. Hence early sowing with its greater risk of night frost favours the shooting.

In dealing with the importance for the farmers of avoiding if possible this shooting there are two aspects from which to view the matter. *1*, The loss and nuisance for the fabricant, which will be dealt with in the last chapter; *2*, Losses to the grower, which I will speak about here.

The formation of the stem, flowers and seed demands quite a large part of the energy and food stored in the plant, which otherwise might be expended in forming cells, filled with sugar. Stems are often driven up with great rapidity—as much as 2¾ in. (70 mm.) having been recorded in one day. That this energy and food is lost for our ultimate purpose is abundantly clear.

This is not equivalent to saying that the shooters contain no sugar (some analyses the writer carried out showed results only a few degrees lower than those of good beets); it is simply that if they had grown up normally they would have been heavier at harvest time and have had a bigger sugar content. Moreover they would not have hampered their neighbours by their light-absorbing foliage.

Apart from that, in every well-arranged contract made with a factory one of the conditions laid down will be that shooters must be drawn out or the stem cut out at an early date, this involving extra care and labour. As an instance one reads in a contract "All shooters must be drawn out by July 15th."

---

* "Defiers" are beets, which having wintered in the shed, and been planted out the second year, refuse to follow the standard course of growth and simply keep on vegetating, needing a third year to produce seed.

Although it is only hypothesis we might draw up our beet ancestry as follows:—

Perennial Plants.
|
Biennial Plants.
|
Annual Plants.
|
Beta Maritima. — Beta Vulgaris.
|
Selection Process.
|

Biennial Beets or Factory Beets.	Annual Beets or Shooters.	Perennial Beets or Defiers.

As regards shooters, it may be remarked that Rimpau has sown the seeds of shooters and obtained in the fifth generation a beet as constant an annual as his original was biennial. It may also be stated that Briem has succeeded in growing perennial seed beets which bore seed for three or even four years in succession; this occurrence is, if we mistake not, taken advantage of by seed growers.

(To be continued.)

THE USE OF INFERENTIAL METHODS AS A CONTROL FOR THE CANE AND JUICE WEIGHTS.

By H. E. SAVAGE, Puunene.

Were it possible to accurately weigh or measure all the sugar-house products, in their various stages of manufacture, no necessity would exist for an inferential check figure. However, many plantations can not, or do not, weigh or measure all the products of importance to the chemical control of the factory, so an element of uncertainty is present in the recorded weights. Also, the scales used to weigh the various products may be out of adjustment, or unreliable, so there is always need of some inferential check on the weights.

Perhaps the first inferential check used is given by Prinsen Geerligs (see "Methods of Chemical Control"), and is, that under certain fixed conditions the ratio $\frac{\text{sucrose per cent. cane}}{\text{sucrose per cent. first mill juice}}$ is very close to ·85. Pellet, in Egypt, uses the factor ·87 to pass from sucrose per cent. juice obtained by treble crushing to sucrose per cent. cane, and further gives the factor ·84 as being used in Mauritius (see *Bulletin*).

Noel Deerr finds the factor for $\frac{\text{sucrose per cent. cane}}{\text{sucrose per cent. expressed juic.}}$

to vary for different varieties, and also that the same variety varies in different locations; thus, Lahaina cane in the Hawaiian Islands, on the Island of Maui, gives the factor ·865, while the same variety, on the Island of Oahu, gives the factor ·834 (see *Bulletin, No. 30, Experiment Station, Hawaiian Sugar Planters' Association*). The writer has made a number of determinations for this factor on Lahaina cane on Maui, Hawaiian Islands, and has found the factor $\frac{\text{sucrose per cent. cane}}{\text{sucrose per cent. crusher juice}}$ to average ·825, with a maximum of ·848, and a minimum of ·810.

These variations are due in part to the varying fibre content of the cane, and the settings of the mills, in part to the locality and variety of cane, and in part to whether the crusher, first mill or mixed juice is used as a basis of reference. This ratio would tend to rise if the cane were flumed or wet by rain, as the adhering water would mix with the juice extracted and give a lower sucrose per cent. juice. If the cane were burned before cutting, this factor would tend to rise, due to the evaporation taking place in the rind of the cane, thereby lessening its weight and causing a rise in the sucrose per cent. cane, while the sucrose per cent. extracted juice would not be appreciably affected. Whatever the cause, it is evident that the large variations, as shown above, vitiate to a considerable degree the usefulness of this figure as a control over the cane weights.

The objections to the use of the "Sucrose Ratio," as an inferential control, are largely obviated by using the ratio, $\frac{\text{Brix absolute juice.}}{\text{Brix crusher juice}}$ The method of obtaining this ratio was given by the writer in a previous number of this Journal, and its value, as he found it, lies very close to ·96. This ratio is not appreciably affected by the changing conditions of fibre content and mill settings, nor, according to Noël Deerr, is it affected by different localities or different varieties. It is, however, appreciably affected by the juice used as a reference, hence it is necessary to specify whether it be crusher juice, first mill juice, or mixed juice. It is also affected by fluming the cane, or by the cane being wet with rain, as most of the adhering water would find its way into the crusher juice, causing the Brix to decrease by a greater amount than the Brix of the absolute juice, hence the ratio would rise. Furthermore, if the cane is burnt before cutting, the heat, by evaporating a certain amount of water from the rind of the cane, causes the solids per cent. absolute juice to rise, while not affecting the solids per cent. crusher juice. The writer has found the increase due to this cause to be about 3 per cent.

From the foregoing, therefore, it is advisable for each factory to occasionally shut off the maceration water long enough to take the necessary samples and determine the value of the factor in question, and, at the same time, the per cent. of juice and sucrose extracted by

each set of rolls may be obtained, thus giving a valuable check on the efficiency of the crushing plant.

The application of this ratio as a check on the cane weights has been worked out by Noël Deerr, and the final form is as follows :—

$$1 + (1 - f)\,P = a + \frac{f}{m}.$$

The cane is denoted by unity, the fibre per unit cane by f, and fibre per unit megass by m, the juice per unit cane by a, and the value of P is as follows :—

$$\frac{a\,(B_c\,m - B_j\,m) + f\,(B_c - m\,B_c - B_m + m\,B_m)}{a\,(B_j\,m + f\,(B_m - m\,B_m)}$$

where a, f, and m have the same significance as given above, and where B_c, B_j, and B_m are the degree Brix or total solids per cent. in the absolute juice, mixed juice, and residual juice in megass, all expressed per unit weight.

The above quickly simplifies to a simple quadratic equation of the general form $Ax^2 + Bx + C = D$, x being the only unknown quantity, and by its use, with analytical data alone, all the essential measurements connected with mill control can be expressed in terms of cane, and if either the weight of cane, of megass, of mixed juice, or of added water be known, all the other quantities can be calculated.

The writer uses a more simple method for checking the cane weights, which is best shown from an example of a day's work done by the Puunene mills.

The recorded data were as follows :—

Average Brix of crusher juice		21·4
Average fibre content of cane..		11·07
Tons solids in mixed juice	415·77	
Tons solids in megass	29·98	
Tons solids in cane..	———	445·75

Then Brix of absolute juice is ·961 × 21·4, or 20·57, and solids in absolute juice per cent. cane = 20·57 × (1 — ·1107) = 18·29.

Tons solids in cane ÷ solids per cent. cane — tons cane, or 445·75 ÷ ·1829 = 2437 = tons calculated cane. Tons cane as per cane weigher 2427, showing a difference of about 0·4 per cent., which is well within the limit of error.

In the above the weight of the mixed juice is taken to be correct, and the tons solids in the megass are found by dividing the tons sucrose in the megass by the purity of the last mill juice. This check is very simple and gives almost identical results with Noël Deerr's formula, but of course is only applicable to factories which weigh their cane.

One other point which is worth considering is the figure called Apparent Juice Extraction, obtained by the Hawaiian factories, as follows :—

Let B = Brix of crusher or first mill juice;
,, b = ,, ,, dilute juice;
,, p = juice per cent. cane;
Then apparent juice extraction $= \frac{b\,p}{B}$.

This formula assumes that the combined juice from all the rolls, expressed without maceration, has the same Brix as that expressed by the crushers or first mill, an assumption that is not strictly true, and furthermore, it makes no allowance for different fibre per cent. cane, hence it is evident that a factory having a low fibre content, and tabulating solids per cent. first mill juice, should obtain a better apparent juice extraction than a factory having a cane of high fibre content and tabulating solids per cent. crusher juice.

In a series of dry crushing tests made by the writer, the Brix of the mixed juice was found to average ·986 times the Brix of the crusher juice, and to deviate but little from this figure. If then we write $\frac{b\,p}{\cdot 986\,B}$ we will have the juice extracted per 100 cane, and if this figure is divided by unity less the fibre content of the cane, we have a figure which represents the juice extracted per 100 juice in the cane, a valuable figure for comparative purposes.

Recapitulation.—Knowing the purity of the residual juice to be practically the same as the purity of the last mill juice, we have a basis for calculating the analysis of the absolute juice, which gives us a rapid, accurate and rational method of determining the fibre content of the cane, gives a most useful check on the cane or juice weights, and finally the relation between the solids per cent. expressed juice to solids per cent. crusher juice offers a valuable figure for the efficiency of the crushing plant. For all these uses, however, it is important to remember that they are based on analytical data and therefore are no more accurate than the data upon which they are founded, nor is it the idea of the writer that these methods should supersede scales and measuring tanks, but that they should merely be used as checks on the accuracy of the scales or recorded weights, or, in the absence of any weighing or measuring device, they may serve as a possibly firmer basis upon which to rest the calculations.

The exports of sugar from Trinidad to Canada have shown a large increase since 1903, when the value was but $124,000. In 1904 when West Indian sugar largely replaced German beet on the Canadian market, the export increased nearly tenfold in value, viz., to $1,074,000. There has been a steady increase since that date, the value of the sugar in 1909 having been $1,413,810. It may be added that the increase in imports into Trinidad from Canada is chiefly in the items of fish and flour

METHODS OF CHEMICAL CONTROL FOR CANE SUGAR FACTORIES ADOPTED BY THE HAWAIIAN SUGAR CHEMISTS' ASSOCIATION.

Drawn up by the Committee on Revision of Methods,
Consisting of
N. Deerr (Chair), H. Johnson, H. I. Savage, G. Giacometti, and R. S. Norris,
and adopted by the Association.*

DEFINITIONS.

In these methods the terms cane, fibre, and normal juice have the following significances:

Cane is the raw material in the condition in which it enters the mill, including adhering field trash.

Fibre is the total insoluble solids in the clean cane *plus* the total insoluble solids in the trash; the determinations must be made separately.

Normal Juice is the entire cane juice.

ANALYSES.

Cane.

Fibre.—As many samples as possible should be taken from the cane from each field as delivered. In lieu of this, as many samples as possible should be taken from the carrier up to one every two hours. A sample should consist of three or four entire stalks. An aliquot portion of about 200 grms. of these should be weighed, chopped up into pieces $\frac{1}{8}$ in. (3 mm.) or less in diameter, placed in a strong linen bag, and the juice pressed out with an hydraulic press. The sample is then treated with cold running water for two minutes, and again pressed, the two operations being repeated alternately five times. The bag is then placed in an air-bath at 125° C. for half an hour, after which the fibre is removed from the bag and dried in a shallow dish for four hours at the same temperature. When an hydraulic press is not available, the sample may be treated in cold running water for 12 hours and dried as above described. Before chopping the sample it may be passed through a hand mill to remove the greater part of the juice.

Instead of washing in water, a convenient portion of the finely-divided sample may be dried four hours at 100-105° C. and the per-cent fibre calculated by the following formula:

$$f = \frac{100\,m}{100 - b}$$

in which f = percentage of fibre in cane
m = ,, ,, moisture in cane
b = ,, ,, total solids in normal juice.

*What follows is abridged from a more detailed compilation published by the Committee.

In determining the fibre in the cane, the amount of field trash weighed with the cane should be determined twice a week on one average car, the amount of fibre determined and added *pro rata* to the amount of fibre found in the sample of clean cane. When not actually determined, the fibre in the trash may be assumed to be 60 per cent.

Sucrose.—The per cent. sucrose may be calculated by one of the following formulae:

$$\frac{\text{Sucrose per cent. normal juice (100 — percentage of fibre in cane}}{100}$$

or $$\frac{\text{Wt. sucrose in mixed juice} + \text{wt. sucrose in bagasse}}{\text{Wt. cane.}}$$

Normal Juice.

Total Solids.—The total solids of the normal juice are found by averaging the total solids of the juices from the different sets of rollers and from the bagasse, when no water is being used on the mills. The test is made as follows:

All water having been shut off, samples of juice and bagasse are taken from each set of rollers, and also a sample of cane for fibre. The Brix, polarization and purity of the juices, and the polarization and moisture in the bagasse samples are determined. From the polarization and moisture content of the bagasse samples and the purities of the juices, the fibre content of the bagasse samples is calculated. From the ratio of fibre per cent. cane to fibre per cent. bagasse, the juice extraction per cent. cane for each set of rollers is calculated, and from the latter and the Brix of the juices, including the residual juice of the final bagasse, the Brix of the normal juice is calculated.

This method is recommended as the most correct for determining the ratio, and also because it furnishes the juice extraction for each mill, from which it is possible to determine errors in mill settings.

Alternatively the Brix of the normal juice and the ratio may be obtained from the following data: percentage of fibre in the cane, Brix of all the expressed juice, Brix of the first expressed juice, moisture and sugar in the final bagasse. In using this method it is of essential importance to remove all dilute juices from the mill bed, gutters, and sump before any samples are taken.

In lieu of the determination of the ratio, it may be taken as 100 when the cane is flumed or burned over in the field, or as 97 when neither flumed nor burned.

Purity.—The purity of the normal juice is found by averaging the purity of the mixed juice with that of the residual juice of the final bagasse. For the purpose of this calculation the latter should be considered the same as the purity of the last mill juice. The calculation may be expressed by the following formula:

$$\frac{\text{Juice extraction} \times \text{purity mixed juice} + (100 - \text{juice extr.}) \times \left\{ \begin{array}{c} \text{purity of} \\ \text{the} \\ \text{residual juice} \end{array} \right\}}{100}$$

By juice extraction is meant the percentage of juice extracted on the total juice in the cane, and for this formula may be considered to be equal to extraction per cent. sucrose in cane.

Percentage of Sucrose.—The percentage of sucrose of the normal juice is expressed by the formula:

$$\frac{\text{Brix normal juice} \times \text{Purity normal juice}}{100}$$

Juices.

Samples of crusher or first mill juice, last mill juice, mixed juice, clarified juice and syrup should be taken continuously when possible and run into clean containers, to which have been added about one part of formalin to 1000 parts of juice. The first of these samples should be taken from the crusher, or in absence of a crusher from the front roller of the first mill. The density should be taken with a corrected Brix spindle graduated at 27·5° C., or with a refractometer. Before taking the density, the juice should be freed from air, particles of trash be removed from the top, and sand or dirt allowed to settle. The percentage of these solid matters in the mixed juice should be determined approximately and deducted from its total weight.

For the determination of the polarization, the juice may be either weighed or measured, using 100 c.c., or double the normal weight as measured in a sucrose pipette. Either dry subacetate of lead or the solution of 54° Brix may be used for clarification, but no more should be used than is sufficient to effect clarification. Juice samples should be analysed at least every six hours.

For the determination of the percentage of sucrose in the mixed juice, place 75 c.c. of the filtrate from 100 c.c. of the original juice, clarified with neutral lead acetate, in a 100 c.c. flask; add 5 c.c. conc. hydrochloric acid, and proceed as under "Waste Molasses," omitting the addition of the zinc dust or sodium sulphite, and calculating the percentage sucrose from the formula:—

$$\frac{100\left(D - \dfrac{4I}{3}\right)}{142{\cdot}4 - \dfrac{t}{2}}$$

and Schmitz' table.

Press Cake.

Four samples of press cake should be taken from each press as it is emptied, selected from different parts of the press and different parts of the cake, placed in a closed container and analysed at least once in six hours. To determine the polarization, the sample is broken up into fine pieces, 25 grms. weighed out, beaten to a thin paste with cold water, and transferred to a 100 c.c. flask, about 3 c.c. of subacetate of lead solution added, and polarized.

Bagasse.

The method adopted for sampling bagasse, and of determining the moisture and sucrose in bagasse, is that recently given in Bulletin 32, 1910, Agric. and Chem. Series of the Association (and *International Sugar Journal*, 1910, 641-642); either the "double cooker" digester, the quart pot, or a flask connected to a condenser by a piece of rubber tubing so that it may be shaken, may be used.

Brix of Residual Juice.—This should be calculated by the following formula:—

$$\frac{\text{Pol. Bagasse}}{(\text{W}-\text{f})\ \text{Pur. R. J.}}$$

Pur. R. J. = Purity of the residual juice, assumed to be the same as that of the last mill juice.

W = Weight of bagasse + solution, corresponding to 100 grms. bagasse.

F = Percentage fibre in bagasse, which is taken at fifty, there being very little difference in the results with the usual variations in the fibre.

Fibre.—The fibre may be either determined directly as in cane or calculated by difference. When calculated, the results should be checked occasionally by direct determination.

Waste Molasses.

All the waste molasses should be weighed or measured. An average sample should be taken from each tank as filled, and the combined sample analysed once a week.

Total Solids.—The total solids are to be determined by drying or with the refractometer. These methods are given provisionally for the present, without preference, since it has not yet been definitely decided which is the most accurate. The drying is done on filter paper, sand, or pumice stone by one of the following methods:—

(1) About 2 grms. of filter paper are placed in the form of a coil, in a test tube, 5 × 1 in., and the whole dried for two hours in an air bath at 100-105° C. After weighing, the paper is removed from the tube, about 2 grms. of molasses weighed in it, then about 2 c.c. of hot water added, and mixed with the molasses. The paper is replaced in the tube and allowed to absorb the whole of the liquid. The tube is then stoppered with a two-hole stopper, placed in a water bath and the water kept boiling for three hours, a slow current of air dried with calcium chloride or sulphuric acid being drawn through the tube. The tube is wiped dry, allowed to cool in a desiccator, and weighed. The final weight is subtracted from the original combined weight of the tube, paper and molasses, to get the weight of total solids.

(2) About 15 grms. of medium fine silica sand that has been washed with hydrochloric acid, or half that weight of coarsely powdered pumice stone, are placed in a shallow dish with a short stirring rod, and heated sufficiently to drive off all moisture. After cooling in a desiccator and weighing, about 3 grms. of molasses are weighed into the dish, about one cubic centimeter of hot water added, and the liquid

thoroughly mixed with the sand. It is now heated, preferably in a vacuum oven at 75° C., or in an air-bath at 100-105° C. for five hours, cooled in a desiccator, and weighed. The weight found, *minus* the weight of the dish *plus* sand, equals the weight of total solids.

In using the refractometer for determining the total solids in molasses, 25 grms. is weighed into a small beaker, from which it is washed into a tared flask with 25 grms. of warm distilled water. After mixing thoroughly by shaking, it is cooled and the corrected total solids as given by the refractometer multiplied by two.

Sucrose.—This is found by the Tervooren-Clerget method recently fully described in Bulletin 31, Agric. and Chem. Series of the Association (and *International Sugar Journal*, 1910, 577). If 35·816 grms. of molasses be used, then the percentage of sucrose is found from the following formula:—

$$\frac{100\,(2\,D - \frac{8}{3}\,I)}{142 - \frac{t^\circ}{2}},$$

in which

D = Direct reading.
I = Invert reading.
t° = Observed temperature of inverted solution.

Raw Sugar.

A few grms. of sugar should be taken from each sack as it is filled, and placed in a closed container. Every twelve hours the combined samples are taken to the laboratory, thoroughly mixed and the polarization, per cent. sucrose and moisture determined.

Polarization and Percentage of Sucrose.—The normal sugar weight of the sample is dissolved in water in a 100 c.c. flask, from one to two cubic centimeters of lead solution added and made up to the mark, or the solution is made up to the mark first and about $\frac{1}{2}$ grm. of dry lead subacetate added. The filtrate is polarized in a 200 mm. tube.

To 50 c.c. of the filtrate obtained as above, but clarified with neutral lead acetate in a 100 c.c. flask, 5 c.c. of conc. hydrochloric acid is added and the inversion carried out in the same way as for waste molasses, except that no zinc dust is used, and the reading is made in a 200 mm. tube. The percentage of sucrose is calculated by the following formula:—

$$\text{Percentage of sucrose} = \frac{100\,(D - 2I)}{142{\cdot}66 - \frac{t^\circ}{2}}$$

in which the letters have the same significance as under molasses.

Moisture.—About 2 grms. of sugar are weighed on one of a set of double watch glasses, made to fit together tightly with a clamp, and heated in an air-bath at 100-105° C. for three hours, the watch glasses are then placed together, cooled in a desiccator, and weighed. From the loss in weight the percentage of moisture is calculated.

GLUCOSE DETERMINATIONS.

The gravimetric method is recommended for glucose determinations, and the copper in the precipitate determined electrolytically or volumetrically.

POLARIZATIONS, GENERAL.

All measuring apparatus should be standardized for Mohr cubic centimeters and 27·5° C.

Quartz plates used for the control of polariscopes should be compared with the standard plates at the Experiment Station of the Hawaiian Sugar Planters' Association.

CALCULATIONS.

Dilution.—The term is used to indicate the percentage by weight of water that has been added to the normal juice extracted, and is calculated by the formula:—

$$\frac{\text{Brix normal juice} \times 100}{\text{Brix mixed juice}} - 100$$

Extraction.—As ordinarily used in Hawaii, this term refers to the extraction per cent. sucrose in cane, which means the percentage of the sucrose in the cane that is obtained in the mixed juice. When the weights of cane and mixed juice are known, this is calculated by the formula:—

$$\frac{\text{Percentage of sucrose in mixed juice} \times \text{wt. mixed juice}}{\text{Percentage of sucrose in cane} \times \text{wt. cane.}}$$

When accurate weights are not available, it may be calculated b— the formula:—

$$\text{Bagasse percentage in cane} = \frac{\text{100 fibre percentage in cane}}{\text{Fibre percentage in bagasse.}}$$

$$\text{Sucrose in bagasse percentage on cane} = \frac{\text{Bagasse percentage in cane} \times \text{sucrose percentage in bagasse*}}{100}$$

$$\text{Extraction percentage in cane} = \text{sucrose percentage in cane} - \text{sucrose in bagasse percentage on cane.}$$

$$\text{Extraction percentage on sucrose in cane} = \frac{\text{Extraction percentage in cane} \times 100}{\text{Sucrose percentage in cane.}}$$

Juice extraction per cent. juice in cane may be calculated by the formula:—

$$\text{Soluble solids percentage in bagasse} = \frac{\text{Sucrose percentage in bagasse} \times 100}{\text{Purity residual juice.}}$$

$$\text{Juice extraction per centage in juice on cane} = \frac{100 \times \text{bagasse percentage in cane} \times \text{soluble solids percentage in bagasse}}{\text{Brix normal juice (100 — fibre percentage in cane.}}$$

Juice extraction per cent. cane may be calculated by the formula:—

$$\text{Juice extraction percentage on cane} = \left\{ \begin{array}{l} \text{juice extraction percentage} \\ \text{of juice in cane} \\ \times \text{(100 — fibre percentage} \\ \text{in cane).} \end{array} \right\}$$

*In these calculations sucrose percentage in bagasse is assumed to be the same as the polarization of the bagasse.

Mixed juice per cent. cane may be calculated by the formula:—

$$\frac{\text{Juice extraction percentage of juice in cane} \times \text{Brix normal juice} \times (100 - \text{fibre percentage in cane})}{100 \times \text{Brix mixed juice.}}$$

The following resolutions were adopted in connection with the foregoing methods of analysis:—

Polarization of Sugars.—The Hawaiian Sugar Chemists' Association wishes to record that the specific rotation of cane sugar decreases with rise in temperature and that in a quartz wedge, compensating, white light instrument, 26·048 grms of cane sugar when dissolved in 100 Mohr's cubic centimeters at 30° C. and observed at that temperature give a reading or polarization of + 99·7. Since, however, this effect of temperature is equal over all the factory products, no error is introduced into the control work, and it is therefore not recommended that any attempt be made to adopt a normal weight which would give a polarization of 100° at the average local temperature. But since sugars are polarized at New York and San Francisco at temperatures lower than obtains locally, the Association is of the opinion that in comparing local and mainland polarizations this increase in the specific rotation of cane sugar be kept in mind.

Further, this Association recognizes fully the detailed and valuable work of C. A. Browne on the effect of temperature on the polarization of sugars, in which it is clearly shown that low grade sugars containing much levulose may even suffer a rise in polarization with increase in temperature, but since the export of Hawaiian sugars consists mainly of high grade sugars of about 97° polarization, the Association is of the opinion that such sugars will invariably increase in polarization with decreasing temperature.

Finally, the Association wishes to record that distinction between the polarization and the percentage of sucrose of a sugar, and while agreeing that the polarization of a sugar is an equable and convenient basis for the purpose of trade and commerce and for the imposition of custom duties, it is of the opinion that for a logical system of mill control the sucrose percentage of the sugars and not the polarization should be employed.

Analyses.—The Association wishes to record that such determinations of sucrose as enter into the calculations of yield and losses in a cane sugar factory should be made by the Clerget, or double-polarization method, and that the polarization and percentage of sucrose of a cane sugar house product be carefully distinguished.

Further the Association is of the opinion that for the above mentioned analyses the true total solids and the true purities should be used; these analyses should include sucrose in mixed juice, sucrose in sugars, and sucrose in waste molasses.

REPORT OF THE QUEENSLAND SUGAR EXPERIMENT STATIONS, 1910.

This year's Report, issued by the Commonwealth Government, is a comparatively brief one, as hardly any new experiments were commenced owing to the necessity of restoring the bulk of the Experiment Station land after seven years of almost continuous cropping.

We are first supplied with some particulars of the restoration work which may profitably be transcribed here. Owing to the relative smallness of the experimental area, a great deal of time could not be afforded to rest the land. In some cases the land has had six months' spell, while in others ten months have been allowed. The means adopted for restoring the land thrown temporarily out of cultivation have been :—

After ploughing out stools and removal (which latter operation is performed to prevent contamination of any succeeding crop), the land is deeply ploughed crossways with the swing plough to thoroughly break up and stir the soil, and to allow the sun and air to have full scope for their sweetening and restorative work.

The land is then ploughed lengthways with the swing plough, going down to a depth of 12 to 14 inches. This is followed by the subsoiler in the same furrow, which reaches a further depth of about 8 inches. We then have a perfectly fine, loose bed in first-class order and of a depth of from 18 to 20 inches.

Next, the sowing of a leguminous crop, to restore humus and nitrogen, takes place. The seed used in most of the land was the small, red Mauritius bean; on other areas a mixture of black Mauritius bean and cowpea was used.

The work was commenced in October after the stools from the previous crops have been removed. By the end of November the green crops were sown on most of the land and harrowed in. Good rains followed, combined with great heat, and in the course of under three months an immense crop of green fertilizer three feet high was ready for the plough. A portion of the crop was weighed on the land, and it was estimated that fully 22 tons of foliage per acre had been produced. The restoration of humus and nitrogen to the soil would therefore be very large.

On one area the land was not subsoiled till after the green crop had been ploughed in. The date of the sowing of the green manure was much later, and the ploughing-under did not take place till May. The sub-soiling was therefore not done till almost immediately before planting in July.

In connection with the concluding experiments, with some ten Hambledon seedlings, second ratoons, (commenced in 1907) the Report

states that the final cultivation "consisted in the shallow stirring of the surface soil, between the rows, with a *Planet Junior* cultivator fitted with three broad duck-foot hoes. This method, when a fine tilth has first been obtained by deep cultivation, is very much superior to using implements which dig or cut the ground, for the following reasons :—1, Cutting implements are very apt to cut newly-formed roots, which the cane is making and thus throw the crop back; 2, the use of digging tines tends to the loss of soil moisture; 3, the *Planet Junior*, with the broad hoes, breaks the fine capillary tubes which are leading water to the surface of the ground, and leaves a mulch of soil on the top which effectively protects the underground moisture during a dry spell. When showers fall during a dry period this method of cultivation is very important, for, when the top soil is damp, it leads to connection with the underground moisture, and much may be lost by evaporation, but if the fine tubes are again broken the moisture will be conserved. This surface cultivation need not at first be more than 3 inches deep, and should it be found that roots are being brought out on the hoes it may be reduced to 1 or 2 inches."

The Report states that two new sugar cane experiments were initiated last year to be carried out in duplicate. The first of these was a series of plats to determine whether the trashing or stripping of the cane plant pays. As pointed out in the previous year's report, a number of experiments have been carried out at the Experiment Station, Hawaii, in which it had been clearly proved that the stripping or trashing of cane did not pay; in fact the practice resulted in a distinct loss, causing a lower yield of sugar and cane per acre. It was decided to carry out similar experiments at the Mackay Station in order to find out if the same results would hold good for Queensland. If it can be proved that stripping the cane is of absolutely no benefit to the crop but has an injurious effect on the yield, it will relieve many farmers, who now trash their cane under the belief that they are carrying out good work, of a great deal of labour and expense.

The second experiment deals with ratoon cultivation about which a good deal of controversy exists in Queensland. The burning of the trash is largely advocated by a number as a means of getting rid of fungus and insect pests and leaving the ground clear for good cultivation. Others believe in relieving the trash in every other row and cultivating the alternate rows. A third party advocate the burying of the trash between the rows, while a fourth are clearly convinced that the proper method is to allow the trash to lie where it falls, and simply to let the succeeding ratoon crop volunteer. This latter course is much practised about Mackay.

In order to endeavour to solve this important question, the Experiment Station has this year laid down in cane two separate areas for a

duplicate experiment. After the removal of the stools from the previous crops, the land was ploughed to expose the turned furrows to the action of the air and sun. This was followed on one area by ploughing and subsoiling, so carried out that all the ground was moved to a depth of from 19 to 21 inches. A green crop of small red Mauritius bean was then sown, and in three months a good, heavy crop of green manure was ploughed under and allowed to rot down. Cross ploughing followed, and four plats were then laid out and planted at the beginning of April, a mixture of New Guinea 15 and 24B being used in each row for plants.

The second area received somewhat different treatment. After the ploughing out of the stools and the ploughing for sweetening purposes, a green crop of mixed cowpea and Mauritius bean was put in. This also yielded a very large mass of green manure, and was subsequently ploughed under, the deep ploughing and subsoiling not being carried out till after the green crop had rotted. The plats for this duplicate experiment were laid out in July, and the planting was also done towards the end of July, the variety known as New Guinea 24B being used for the planting.

The rows in both these experiments have been placed at 6 feet apart so as to give plenty of room for dealing with the trash.

Should the results from both series be similar, then it is considered that great reliance can well be placed in the results.

Some interesting experiments were also undertaken to test the value of inoculation with Professor Bottomley's nitro-bacterine culture. These were carried out on the seeds of three leguminous varieties, the Iron Age cowpea, the red Mauritius bean, and the black Mauritius bean. The seeds were divided into two parts, one half being dipped in nitro-bacterine culture, and the other half left untreated. The two sets were sowed in properly guarded rows, and when reaped the crops were carefully weighed. In two cases the inoculated seed beat the non-inoculated in yield per acre, the third case going to the non-inoculated. Analyses were made of samples taken from the respective crops, and here a decided advantage of using the culture became apparent, the percentage of nitrogen found being uniformly higher in the inoculated crops than in the not inoculated.

The results are tabulated below:—

YIELDS.

	Tons per Acre.	
	Inoculated.	Non-inoculated.
Cowpea..	17·28	15·91
Black Mauritius Bean	9·72	11·34
Red ,, ,, ...	13·50	12·96

ANALYTICAL RESULTS.

	Percentage of Nitrogen in Inoculated Crop.		Percentage of Nitrogen in Non-inoculated Crop.
Cowpea..	0·611	..	0·549
Black Mauritius Bean	0·704	..	0·663
Red ,, ,, ...	0·763	..	0·721

POUNDS OF NITROGEN PER ACRE.

	Inoculated.		Non-inoculated.
Cowpea	236·5	..	195·6
Black Mauritius Bean	153·2	..	168·4
Red ,, ,, ...	230·7	..	209·3

The cost of the Culture is 7s. 6d. per packet, which suffices to inoculate seed for more than an acre.

DISPOSITION OF WASTE MOLASSES FROM HAWAIIAN SUGAR HOUSES.

By T. F. SEDGWICK, Sugar Expert, Honolulu.

The profitable disposition of the waste molasses from the Hawaiian sugar houses has long been a problem before the planters for solution. Unlike many other cane sugar growing countries, Hawaii has never made rum or alcohol to any extent, so that it has not had that source of revenue. There are reasons for this which may be of sufficient interest to mention.

When Captain Cook discovered the Hawaiian Islands, in 1778, he found a people ignorant of the use of rum or common liquors, though they did have a national drink called "Awa," which was narcotic in its effects rather than intoxicating.

The liquors introduced by the new comers who followed the discoverers were used freely by the natives. They were taught to make an intoxicating drink out of the root of an indigenous plant named Ti, and although cane was then growing here it was not used for distilling liquors.

The reigning king, Kamehameha the Great, himself partook of the new drinks at first, but he foresaw the evils that would come upon his people if they continued in their cups, and forbade the further use of all intoxicating liquors, and abolished the stills. He had a good adviser in the person of Young, one of the crew who remained on the Islands after the massacre of Captain Cook.

The missionaries who came in 1821 used their influence against intoxicating beverages, and for a long time their views and teachings had great weight with the Kings and Queen-Regents and High Chiefs.

Under such conditions very little attention was given to making rum or alcohol from the waste molasses coming from the sugar mills. There was, however, a demand for the molasses in foreign countries during the early years of sugar making. But this demand gradually ceased and the planters had a product on their hands that seemed of little value, but of considerable bulk and trouble. The very fact that so little use could be made of this molasses had the effect of making them look carefully for ways and means of extracting the utmost sugar possible from it. Had rum been made, the necessity would not have been so great, as it sometimes pays to make low grade sugar into rum.

When the Islands were annexed to the United States (1898-99), it was thought that distilleries might be introduced. About this time the writer interested himself in finding a way to use the molasses other than in making alcohol. Acetylene gas was then exciting considerable interest, and its possibilities and limitations were not fully investigated. The writer thought that the gas might possibly be used in engines to pump water on the plantations. This was before the general introduction of fuel oil, and the coal bills were very heavy. After a little experimenting, a carbide of good quality was produced which gave off the characteristic acetylene gas flame. The materials, coral sand and waste molasses, were to be had almost for the asking, but acetylene gas engines had not been perfected, and the danger in using the carbide was considerable, so that nothing in a practical way has been accomplished as yet.

Although annexation legalized the fermenting and distilling of liquors by complying with the revenue laws, there has been no effort of any consequence to utilize in that way the waste molasses from the 525,000 tons of sugar annually produced. Messrs. Eckart and Peck place the amount of molasses at about 15,000,000 gallons.

The two problems that confront the planter are to find ways of extracting still more sugar from the molasses and a profitable use for the waste.

Fermenting and distilling rums or liquors to be used as beverages.—Should the planters decide to instal distilling plants, it would mean an outlay of about $2,000,000 to equip all the sugar houses with the proper appliances. As there has been no rum made in Hawaii, it is fair to say that there are few, if any, expert rum manufacturers in the Islands, and good experts in this line are difficult to find.

The good qualities of a first grade rum depend very largely on the quality of the molasses from which it is made. The Hawaiian molasses has been returned to the vacuum pan and re-boiled to such an extent that it is quite probable it would not give a fine rum without elaborate rectification. An example of the bad effects on the quality of rum produced by excessive boiling back was brought t the writer's notice in Peru.

An artificial liquor manufacturer had been buying his rum from one plantation for some time and had found it satisfactory; but a number of cargoes came which produced an undue amount of "head alcohol" and very little liquor that could be used in manufacturing his high grade beverages. The writer found on investigation that the sugar manufacturer who sold the molasses had modified his method of boiling by returning the molasses to the vacuum pan and re-boiling to such an extent that the aroma and flavours required in the rum were destroyed and a low quality rum resulted.

The Hawaiian planters have never been warm advocates of rum making, and many of them have been strongly opposed to allowing liquors of any kind to reach the hands of the Hawaiians. The question of protecting the Hawaiian people against the excessive use of liquors has just recently again been brought to one's attention in the shape of "prohibition" for the Islands. The conflict reached the point of referring it to the United States Congress for solution.

That body, after careful consideration, decided to put the question to a vote of the Hawaiian citizens which took place on July 26th, resulting in a verdict *against* "prohibition." But even though prohibition was defeated, the agitation will doubtless have its influence on the future manufacture of liquors in Hawaii, since distillers would hesitate to invest money in an enterprise against which there is so strong an opposition.

Denatured Alcohol.—When the United States Government enacted the regulation permitting the manufacture of denatured alcohol, many supposed denatured alcohol would be used in large quantities for power and fuel, and that it would lead to extensive distillation, and that the waste molasses from the sugar houses could be turned to profitable use. In countries where denatured alcohol has been used for years, the progress of putting it into general use has been slow, and this, too, with the aid of some of the best scientists and practitioners. It is not surprising, then, that the good effects of this regulation on the part of the United States were not immediately felt.

Making denatured alcohol from the waste molasses of the Hawaiian sugar houses will depend upon whether or not it will pay. If it is made, it will have to compete with denatured alcohol made on the mainland, or profitable ways will have to be found of using it in the Islands for pumping, locomotives, fuel for labourers, &c., and it will take time to determine whether there is profit in so utilizing the waste molasses. So for the present at least it looks as though the Hawaiian planter will continue to dispose of his molasses on his own plantation.

Part of it is already used as stock food, which is a direct profit to the plantation. Some of it is burned, which, in some cases, is of no particular profit, as the mills already have enough fuel. Some of

the molasses is run into the waste waters which are run on to the fields or to the sea. Sometimes it is mixed with the irrigating waters and run on to the fields, with the object of deriving some fertilizer value from it.

Its value as a fertilizer or soil renovator has not yet been determined. Considering the actual amounts of fertilizing elements the molasses contains, its value is no more than a low grade fertilizer, but the results obtained from its use on soils containing *sufficient* amounts of carbonate of lime are as good as are produced by rotation, intensive cultivation, and fertilization. This is probably due to the fermentation of the molasses in the soil which greatly assists soil renovation.* In recent years there has been a good deal of evidence brought out to show that the value of a fertilizer is not altogether dependent on the nitrogen, potash and phosphoric acid which it contains. In fact a mixture containing only inappreciable quantities of these substances may be highly beneficial to a soil. The value of molasses as a fertilizer for certain soils cannot always be reckoned from the amount of fertilizing elements it contains. If it produces the same results as rotation of crops or a high grade fertilizer, its value is equal to that of an expensive fertilizer. Instead of being worth $5 to $10 a ton, for some soils it might be worth $30 a ton, considering its actual beneficial value to the soil and cane.

Another use to which the waste molasses might be put on the Hawaiian plantations is in making gas for fuel. It is the custom to allow a labourer, besides his house or room, wood enough for his domestic use. This is no small item, and at times it is not easy for the plantations to get wood for their labourers.

Some years ago the writer looked into the question of making fuel gas from waste molasses, and the results of the experiments seemed to indicate that it would be profitable for the plantations to utilize the waste molasses in this way. Filter press cake, mixed with molasses could be used in the same way. The utilization of waste molasses in making gas is worth thorough investigation.

It is difficult to predict in what manner these fifteen million gallons of waste molasses will eventually be disposed of. Certain it is that this now waste product is destined to be of considerable profit to the Hawaiian plantations if properly handled.

---

* Some years ago the writer carried on experiments with the object of noting the behaviour of certain organic substances fermenting in the soil. These are to be found in *Bulletin No. 5 of the Sugar Experiment Station, Lima, Peru.* The deductions drawn from these experiments were that such materials under certain conditions acted as soil renovators, indirectly fertilizing the soil. Although waste molasses was not one of the materials used in the experiments, it is more than probable that its action on the soil is similar to that of the materials that were used, viz., citric acid, alfalfa tops, tree roots, cane roots, &c.

11 ROLLER *versus* 14 ROLLER MILLS.

In a recent article Mr. Noël Deerr discusses the advantage of the 14-roller mill over the 11-roller mill. Of course it pays the factory owners to grind as much cane as possible. It is possible to increase the size of the rest of the Factory by 40 per cent. but not the size of the mills. In that case it is profitable to use the 14-roller mill and grind 40 per cent. more cane with equally good results. But a strict comparison of the two systems can only be made in the following manner:—

Does it pay to grind an equal quantity of cane in an equal time. in one case with a fast running 14-roller mill, or with a slow running 11-roller mill of larger size? I assume that both sets cost the same (an engineer's firm could give the actual prices), then there is, with equal quality of mill work, no advantage at all. Now, there remains another question to consider: what pays better, to grind slow and do better work, or to grind fast? In this case we must compare one 14-roller mill with another 40 per cent. larger. This question comes in when erecting new plants for a given amount of cane.

Say the larger mills do 40 per cent. more work and cost 40 per cent. more. Let the first one be a mill 30 in. $\times$ 60 in. grinding 25 tons of cane per hour, and the other set grinding 35 tons per hour. When grinding 35 tons per hour with the smaller 14-roller mill we do the same quality of mill work as when grinding 25 tons with 11 rollers.

Suppose the fibre content of the cane is 15 per cent. as is the case here, and we lose on 100 fibre 60 parts of first mill juice in the megass with 11 rollers. The fourth mill will bring this down to 40 to 45, say 45 to be on the safe side. Cane ground $=$ 50,000 tons: the gain amounts to $\left\{ 50{,}000 \times \frac{(60-45)}{100} \times 15 \right\} \div 100 = 1125$ tons of first mill juice (but of lower purity).

Our first mill juice is 21·65 brix and 90·5 purity. Take the purity six degrees lower. The sucrose content is 19·14. The first mill juice lost on 100 fibre is calculated with the sucrose percentages, so we can take the increased extraction of sucrose as $\frac{1125 \times 19{\cdot}14}{100} = 253$ tons. Our mixed juice is 86·8 purity. Take the purity of this additional juice $=$ 80·8 and the recovery two per cent. higher $=$ 83 on indicated sucrose. That is, $\frac{252 \times 83}{100} = 210$ tons; this is the gain due to better work with the 40 per cent. larger mill, grinding 35 tons against the fast running smaller mill or (an equally large 11-roller mill).

Say the smaller set cost £16,000, the larger one will cost £16,000 + £6400 = £22,400. The profit is 210 tons sugar @ £10 = £2,100, or on the additional capital $\frac{2100}{6400} \times 100 = 33$ per cent. This is convincing

proof that a slow running 14-roller mill pays better than a smaller fast running set of 14 rollers. The same is the case with two sets of mills. It pays to make them 14 rollers instead of 11-roller mills. To increase the capacity, one can either add two fourth mills and grind faster, just only to be able to grind more canes, but it would then pay to instal a third set of 14-roller mills and obtain better results and grind slower.

With lower fibre content and lower sucrose in the juice the financial advantages will remain about the same, because a given mill can grind more of such canes.

J. Lely.

Gunthorpes, Antigua, B.W.I.

"EPONITE": A SUBSTITUTE FOR ANIMAL CHARCOAL IN SUGAR REFINING.

By F. Strohmer,

Director of the Austro-Hungarian Sugar Experiment Station, Vienna.

The many efforts which have been made to displace animal charcoal, used of old in the sugar refinery as a decolorizing agent, have up to the present time been unsuccessful, and this material still remains absolutely necessary for the production of high-grade refined. This is to be traced to the fact that animal charcoal not only decolorizes impure sugar solutions, but also removes the colouring bodies by absorption, acting in this way more or less as a purifying agent. On the contrary all the decolorizing chemicals hitherto used are either reducing or oxidizing agents, that bleach the colouring bodies without removing them.

By the use of reducing agents, such as "Blankit" (this *Jl.*, 1908, 27), the colouring bodies are only converted into their colourless leuco-base without being destroyed, so that with the resulting product there is always the danger that by gradual oxidation an after-darkening may set in after a time. The presence of these converted colouring bodies in a sugar for ready consumption influences the quality of the same, and the demands of a large class of consumer are not satisfied, besides which the article is more or less unsuitable for certain uses, such as, for example, the production of champagne, preserved milk, fine sugar wares, &c. For each of these reasons the use of animal charcoal cannot be entirely displaced in the refining industry, although the amount used can be reduced to a more or less extent by a more thorough affination.

Recently a decolorizing powder has been placed on the market under the name of "Eponite," which we have had the opportunity of examining.

Results were obtained indicating that it may be taken into consideration as a substitute for animal charcoal in sugar refining, and that even the possibility does not seem to appear unlikely that it may entirely suppress the use of animal charcoal in the sugar refinery, provided that the cost is not too great, and that the conditions for its most favourable action are not prohibitive in practice. Since this matter is certainly one of great importance to the sugar industry we give a short report of our experiments.

"Eponite" is a fine, mealy powder, of a dull, deep-black colour, having the following composition:—water, 9·41; sand and soluble silica, 2·46; carbon, 81·99; hydrogen, 1·72; nitrogen, 0·10; oxygen, 2·64; and ash, 1·68 per cent. The ash contains on an average:—potash, 20·58; lime, 39·29; and phosphoric acid, 2·69 per cent., and has an alkaline reaction. On microscopical examination no very striking characteristic could be recognised, the preparation appearing to be a regular amorphous powder. In consideration of this, and of the chemical analysis, "Eponite" may be viewed as a completely carbonized vegetable substance, probably of wood, and is comparable with "vegetable charcoal."

Examined according to the customary procedure for testing animal charcoal, the sample gave the following figures:—water, 9·41; sand, 2·46; carbon, 87·54 per cent. Thus this material is distinguished from animal charcoal principally by its higher carbon content, since the latter in normal chars only amounts to 12 per cent.

Experiments were then made to determine the best conditions of time and amount to use for decolorization. In doing this a washed (affined) sugar was dissolved in water, giving a liquor containing:—water, 45·88; sugar, 53·70; ash, 0·03; and organic non-sugar, 0·39 per cent.; and having 99·2 true purity, and a degree of colour equal to 1·53 parts on 100 parts of sugar, read in the Stammer colorimeter. 100 grms. of this liquor were treated with 0·67 grm. of "Eponite," for 10 minutes at 80° C. with agitation; then allowed to cool, made up to its original weight with water, and filtered. The filtrate was absolutely water-white and clear, so that total decolorization had been effected. In a similar experiment the duration was only 3 minutes, and here the result was the same. On employing smaller amounts of the "Eponite" similar results were again obtained. Even with only 0·54 grm., *i.e.*, 1 part on 100 of sugar, after 1 minute at 80° C. a water-white, completely decolorized liquid was found. But with less than the last named amount, viz., 0·5 grm. or 0·93 part on 100 of sugar, the filtrate had a slatey-grey appearance, and therefore could not be considered as entirely decolorized.

In experiments on the action of "Eponite" in comparison with animal charcoal we used a new char of fine grain and best quality, containing 4·14 per cent. of water and 11·89 per cent. of nitrogenous carbon on the dry matter, and a liquor having 3·59

parts of colour by the Stammer instrument, a degree of colour seldom met with in modern refinery practice. On treating 100 grms. of this solution with 0·54 grm. of "Eponite" for 10 minutes at 80° C. a completely decolorized filtrate was obtained. Usually 7 to 8 parts of animal charcoal to 100 parts of sugar are used in the refinery for decolorization, and in our experiments we used 3·9 grms. of animal charcoal to 100 parts of sugar liquor, corresponding to 7 parts per 100 parts of sugar. Working in the same manner as with the "Eponite," a filtrate was obtained with 1·4 parts of colour, so that only 61 per cent. of decolorization had taken place. Therefore for this dark-coloured liquor the ordinary amount of animal charcoal was insufficient. Further experiments showed that 5·6 grms., *i.e.*, 10 parts of animal charcoal per 100 of sugar, were necessary. Thus "Eponite" in this case showed 10 times the decolorizing power of the animal charcoal.

The colouring bodies of refinery liquors have their origin principally in products of the superheating of sugar, comprised under the term "caramel." From caramel Ehrlich has separated a typical, definitely characterized body, called "saccharan," (this *Jl.*, 1910, 84), which may be considered as representative of the group. Since, according to Ehrlich (*loc. cit.*), saccharan may be utilised as a standard for the determination of the caramel content of different sugar factory products, it was thought of interest to learn how "Eponite" behaves towards the aqueous solution of this body. For this purpose a solution containing 0·25 grm. of saccharan in a litre of water, and having 14·3 per cent. of colour according to the Stammer instrument, was prepared. This solution was treated with the sample of "Eponite," and with the animal charcoal, under equal conditions; and it was found that, whereas in the case of the animal charcoal no alteration in colour had been effected, there was a decrease of colour with the "Eponite" of nearly 40 per cent.

"Eponite" is not influenced by the reaction of the solution. It does not absorb sugar when heated with concentrated sugar solutions for 10 minutes at 80° C. It does not give up any appreciable amount of soluble matter to the solution. It has a slight de-liming action on impure sugar solutions.

Since the vegetable charcoals, wood charcoal, for example, are mostly capable of acting as deodorants, it seemed to us of importance to see whether this property also belongs to "Eponite." Experiments in this direction with beet juices and osmose waters showed that "Eponite" in common with all other vegetable charcoals has this deodorizing property. Such a property for a decolorizing agent for beet liquors is of special advantage.

Experiments for the purpose of finding how often one and the same amount of "Eponite" can be used, and how the material can best be revivified, have not yet been concluded.

What we have said must, however, have shown that the new decolorizing agent deserves the attention of all sugar refiners, and should induce them to experiment with it on the large scale. The great decolorizing power of this material has as a result that the decolorization and filtration of the liquors do not require such large apparatus as in the case of animal charcoal, and treatment with it in pans or tanks, and the separation of the used "Eponite" by small filter presses, would appear possible. "Eponite" has all the advantages of being used in small amount, such as a small sugar loss, and a small amount of sweetening-off liquor.

We wish especially through our contribution to induce experiments with the new preparation, for we believe that through such an important advance in sugar refining can be made. (Abridged from *Österr-Ungar. Zeitsch. Zuckerind.*)

BEET SUGAR GROWING IN VICTORIA.

While our Home Government professes the utmost indifference to the claims of the new beet sugar movement, the Commonwealth Department of Agriculture is taking an active interest in the inauguration of a beet sugar industry in Victoria. They engaged an expert to investigate matters, and after receiving his favourable report decided to undertake the responsibility of opening the factory at Maffra, which we believe was started a few years back and had to close for want of support. Some 350 growers have promised to put in the aggregate 1000 acres under beets this season, and a start will doubtless be made with that amount of beet.

One of the chief difficulties to be encountered, we learn from a Melbourne contemporary, is the supply of labour, and the Government has prepared a scheme to meet the requirements of the farmers in this connection. The Government has undertaken to organise the field labour necessary for thinning and topping the beet. Mr. Lee, another Government expert, has furnished the Minister of Agriculture with a report on this aspect of the enterprise. In it he states that, in order to ascertain in the most practical manner the earning capacity of unskilled labour at thinning beets, two men selected by the Rev. A. R. Edgar and the authorities of the Salvation Army were last season sent up to Maffra to do this work upon the experimental plots. Both these men made voluntary statements to the effect that they could make 6s. per day at beet thinning, on the basis of 27s. 6d. to 30s. per acre. Experienced onion thinners, which crop entails twice the work of beet thinning, by reason of the rows being only 9 inches apart, instead of 18 inches with beet, have expressed their willingness to take large areas of beet thinning at the above prices. The prospective

beet growers have expressed themselves as quite agreeable to pay from 27s. 6d. to 30s. per acre for beet thinning, provided they have no responsibility of procuring men at the critical time or housing or feeding them. Mr. Lee adds that the prompt thinning of the beet crops governs the ultimate yield more than anything else.

Mr. Lee goes on to say:—"It is perfectly understandable that few persons will go to the country in search of work of unknown character, and with no guarantee of definite earning capacities. I propose to send each person or family to a given number of acres of beet in a specified district, at a fixed rate per acre. There would be a period within which the work must be completed, and passed by the Government supervising officer and the grower concerned, before payment would be made. The approximate areas required to be thinned by contract would be 800 acres. Allowing five days to thin an acre of beet and a thinning period extending over six to seven weeks, it would require about 100 persons to be engaged in the work. If family labour could be arranged for, it would mean that not more than 30 to 40 families are necessary. A family of three could earn from 15s. to 18s. per day, with a guarantee of about six weeks certain labour. When these facts are made known through the proper channel, I have little fear that the response will not be quite satisfactory. In regard to the topping of the beets at harvest time, the same scheme of organised labour can be arranged for. Beet topping in the United States and on the Continent is carried out at a price ranging from 1s. to 1s. 6d. per ton, according to the average size of the roots. Large beets are more easily topped than small ones and weigh heavier."

It is anticipated that the opening of the factory will require the expenditure of between £10,000 and £15,000 this year. This will be provided on the Estimates. A suitable man to engage as manager for the factory is being secured from the United States.

The construction of the new sugar refinery of Sir J. L. Hulett & Co. Ltd., at South Coast Junction, Natal, is making good progress. The buildings are practically completed, and it only remains to fit them up with the machinery and appliances.

Commercial Intelligence states that following the award of a contract for a large sugar mill installation in Formosa to the Honolulu Ironworks Co., two more contracts for sugar mill machinery for Formosa have been secured by American firms, the last having been awarded by the Taihoku Seito Kaisha to the Dyer Co., of Cleveland, Ohio.

RECENT IMPROVEMENTS IN THE DESIGN OF REFINERY PLANT.

By William Clacher, F.C.S.

During the past year there have not been many very noteworthy new features introduced in the manufacture of cube sugar, reference should however be made to two which are of a sufficiently interesting nature to warrant attention.

The first is the improvement of the arrangement for filling the Adant moulds, patented by the proprietors of the original patents; and the second, the attempt to introduce the use of aluminium in the moulding of the sugar in the Adant moulds by a cube manufacturing company.

In the Langen system of moulding an appreciable part of the massecuite was non-productive, since it was not all made into slabs, a certain amount clinging to the outside of the mould and to the tops of the division plates; this sugar required remelting before becoming out-turn.

In the original Adant machines the slabs were made much larger than the Langen slabs, and in general a great economy was effected by this device, in addition to the production of a better cube. The Adant slabs are of equal thickness all over and rectangular, but the Langen slabs were not so, this accounting for the production of the better cube by the Adant system. The moulds are filled above the level of the division plates, and all the masse which is above this, together with the amount left in the small filling hoppers, requires to go through the process again before becoming productive.

The new filling machinery introduced has for its object the charging of the moulds exactly to the top of the division plates. The supply of semi-liquid massecuite is automatically cut off when the required height is reached, and there are no small hoppers to retain any unproductive sugar. In addition, the arrangement allows the air between the division plates to escape without danger of being enclosed in the slabs, which is an exceedingly important detail, since an improvement in this part of the process means a better and a cheaper cube. Slabs of sugar moulded free from air produce less dust at the cutting machines, also they are much less easily broken during the processes of taking from the mould, conveying and drying. These advantages to the manufacturer are so great that there is a lower production of crushed sugar from the same out-turn, and the cubes themselves are more solid, and do not crush to dust in the boxes when being handled on the way from the packing room to the consumer.

The second item mentioned, namely, the attempt to introduce the use of aluminum division plates, was not successful. The reason given by the manufacturers for the failure is that the division plates

supplied buckled during the moulding, producing uneven slabs and consequently irregular goods. They explained that the buckling is due to the fact that the groves for the slides are not usable with aluminium plates, as the very expansive aluminum more than fills the present sized slots. The division plates at present in use are made of iron and are zinc-coated; this zinc wears away rapidly, and the iron gives rusted slabs and unsaleable cubes. The difficulty of the rusting is to a certain extent obviated by dipping the slides after washing in a hot lime-water wash, but the successful application of aluminium in this departure would have made the slabs quite free from rust.

At present in sugar houses aluminium is little used. There are many stages thoroughout the refining process in which the application of this metal would undoubtedly be an advantage. For example, such places as the acid mixers for sulphiting liquors, where there is a liability for iron to go into solution. Aluminium produces non-poisonous non-astringent, and white coloured salts; but iron salts have an unenviable notoriety in sugar refineries, whilst copper is very expensive. With a view to testing the properties of aluminium we have made some experiments with the metal under varying conditions. Previous experiences with the metal have been amply comfirmed, and provided requisite skill is used in the construction of plant, we can without hesitation state that there is much that can be done to improve the refining of sugars by the use of plant of alumimium.

In these experiments an 18·8° Beaumé sugar solution containing 0·8 per cent. sulphuric acid was heated to 160° F., and in it was immersed successively for one hour :—

(*a*) A piece of sheet (commercially pure) aluminium .. alone.

					in contact with
(*b*)	,,	,,	,,	,,	. lead.
(*c*)	,,	,,	,,	,,	.. brass.
(*d*)	,,	,,	,,	,,	.. zinc.
(*e*)	,,	,,	,,	,,	.. copper.
(*f*)	,,	,,	,,	,,	.. iron.
(*g*)	,,	,,	,,	,,	.. silver.

The figures obtained were as follows :—

	Area of aluminium immersed in sq. cms.	Loss in weight, in grms.
(*a*)	46·0	0·0050
(*b*)	50·0	0·0078
(*c*)	37·5	0·0097
(*d*)	68·5	0·0136
(*e*)	46·0	0·0198
(*f*)	46·0	0·0074
(*g*)	51·0	0·0149

It is thus seen that the loss in weight where an electric couple is made is in each case more than where the pure metal alone is acted on, this loss in one case approaching four times as much.

In another set of experiments the procedure was:—

(1) To immerse a piece of aluminium in an 18·8° Beaumé sugar solution, containing 0·5 per cent. (dry) sodium carbonate, for one hour, at 160° F. The area of plate in was 51·0 cms., and the loss in weight 0·005 grm.

(2) To heat a piece of aluminium for one hour in a dilute lime sucrate solution at 212° F. The area of plate was 50·0 sq. cms., and the loss in weight was 0·01 grm.

(3) To heat a piece of aluminium for one hour in a boiling saturated solution of cream of tartar. The area of plate was 15 sq. cms. and the loss in weight ·0004 grm.

(4) To heat a piece of aluminium for one hour at a temperature of 212° F. in an apple jelly. The area of plate was 10 cms., and there was no loss in weight.

(5) To heat a piece of aluminium to 225° F. for one hour in the same apple jelly. The area of plate was 15·0 cms., and the loss in weight 0·0005 grm.

The action of dilute caustic soda is violent, and the use of liquors alkaline by caustic soda is quite unfeasible in aluminium vessels. With dilute sulphurous and phosphoric acid the action on aluminium is slight, so that the only substances in use in refinery liquors which are destructive are caustic alkalis.

The precautions to be taken wherever aluminium is adopted for acid liquors are that *the pure metal should be used and electric couples avoided.*

Mention may here be made of another place in modern refineries where aluminium will likely be a considerable improvement on the present metals used, and that is in the evaporators. These contain narrow tubes, in which liquors are concentrated previous to going to the pans. In the refinery these are largely used for concentrating low-grade charred liquors, which contain a high percentage of ammonium salts; these salts vapourize and attack the brass and copper tubes and cause leakages, in consequence of which there are many repair accounts, together with a lessened yield.

The use of tubes made of a metal that is not affected to any extent by ammoniacal vapours is therefore a great source of economy.

Some preserve manufacturers have been using aluminium pans for a considerable time. Such pans have caused satisfaction, and repeat orders have been given. The experience in that industry, as in sugar refining, with the use of aluminium alloys was very disappointing, the plant made corroding away very quickly.

With further experience, and the purer metal, together with skill in design in avoiding any voltaic currents, a more satisfactory experience is in store for the application of the white, light, non-poisonous aluminium in sugar refining and preserve manufacture. The use of alloys, which up to the present time have proved quite unsuitable for sugar refining and fruit preserving, has caused the metal to be regarded with disfavour. When, however, the qualities of the modern high purity metal become known this unfavourable impression will be forgotten, and the good qualities will be duly prized.

PUBLICATIONS.

THE POCKET GUIDE TO THE WEST INDIES. By Algeron E. Aspinall. New and Revised Edition. London, Duckworth & Co., Covent Garden. 5s. net.

This excellent pocket guide from the pen of the secretary of the West India Committee, since it first saw the light in 1907, has met with a sufficiently generous reception to warrant the author preparing a second edition. Much of the book has been re-written and a new chapter on the Panama Canal added. The whole get-up of the work is excellent.

CONFÉRENCES DONNÉES PENDANT L'ANNEE 1910. By Émile Saillard. Published by the Société Industrielle de Saint-Quentin et de l'Aisne.

With this volume the Committee of the *Société Industrielle de Saint-Quentin et de l'Aisne* publishes the eighth series of the lectures given by M. E. Saillard, the well-known French specialist, who is director of the laboratory of the *Syndicat des Fabricants de Sucre de France.*

The first lectures describe field trials with different varieties of rich beets from both French and foreign seed, and the yield of sugar per hectare in France and in other countries. It is strikingly illustrated that, whereas Germany obtains an actual yield of raw sugar amounting to 15·49 kilos. per hectare, in France this is only 12·82, the lowest figure for the six great beet-growing countries of Europe. Other figures show that it is not that the French root is less rich than that of other countries, for in this respect it takes a favourable place; there are evidently other causes that determine this value, and to investigate them a special commission, composed of distinguished members of the *Syndicat des Fabricants de Sucre de France*, has been formed.

In the next lectures the composition of the new nitrogenous manures, nitrate of lime and cyanamide, are discussed, and their method of manufacture described. Respecting the efficacy of these

new artificial sources of nitrogen, M. Saillard's special field trials have shown that nitrate of soda in combination with potash gives a higher yield than either cyanamide or nitrate of lime, under the same experimental conditions.

In dealing with methods of factory control, it is pointed out that in determining the sucrose content of the root by the aqueous digestion method an error is introduced and low results obtained if the volume of liquid is less than a certain amount, even though the bulk be completed to the mark as usual after cooling. Some useful hints regarding the important question of the correct procedure to be adopted in sampling are also given, and methods are recommended for determining the acidity of diffusion juice and the "index of coagulation," which is now becoming a datum of some importance, especially in connection with Claassen's process of utilizing the residuary waters of diffusion.

Other lectures treat of the Hydross-Rak diffusion process (already noticed in this *Journal*, 1910, 420), centrifugals of large diameter (see this *Journal*, 1910, 201), and the composition of beet molasses. It is worth while noticing in connection with the latter that M. Saillard attaches some importance to the ratio of organic matter to ash. From the analyses quoted it appears that the nitrogen content increases with this ratio, and that both the ratio and the nitrogen content are higher in dry seasons. For sulphated ash the coefficient 0·9 is used.

An account of trials on the Kestner pre-evaporator, a comparison of methods of analysing coal, and some points on superheated steam complete the volume. We congratulate M. Saillard, not only on the valuable matter he is able to collect for these *conférences*, but also upon their style, which is indeed admirably clear and interesting.

We have received from Messrs. John Mc.Neil & Co. Ltd., Govan, Glasgow, a Letts' Pocket Diary and Note Book, to which are added some useful tables for sugar engineers and others; from the Harvey Engineering Co. Ltd., Glasgow, a Wall Calendar for 1911, with a reproduction in colour of a water-colour painting of a monument to Montezuma at Mexico City, from the brush of Mr. Robert Harvey, M.I.M.E.

Mr. G. L. Courthope, M.P. for Rye, recently offered prizes for the best specimens of sugar beet grown in Sussex. The first prize, curious to relate, was won by the Goldsmiths' Company.

ABSTRACTS, SCIENTIFIC AND TECHNICAL.*

The "Clarite" Process of Clarification. *By J. C. Brünnich. Queensland Agric. Jl., 1910, 24, 242-243.*

In his report on the examination of Le Claire's "Clarite" process of clarification (tempering with a mixture of bicarbonate of soda, common salt, and sand, see this *Journal*, 1910, 311), the author, who is the Queensland Agricultural Chemist, stated that from his previous observations on the keeping qualities of sugars he was convinced that the ordinary sugars containing lime salts would be more liable to deterioration than those sugars made by the new process, which are comparatively free from these compounds. This opinion has been clearly demonstrated by the repeated analysis of two samples of sugar made at the same mill within a few days of each other by the two different processes, viz., ordinary lime and "Clarite" clarification. The two bags of sugar were kept side by side in a small dry room, exposed to the ordinary changes of temperature and moisture. So as to avoid unnecessary exposure of the sugar, sampling was carried out by means of a proof stick, except in the case of the final samples, when the whole of the contents of the bags was thoroughly mixed before taking portions for analysis. After seven months, it was found that the sugar clarified with lime showed a loss of cane sugar equal to 2·1 per cent., and a decrease in the net titre from 96·88 to 93·06; whilst the "Clarite" sugar showed a slight increase in quality, due to a slight loss of moisture. It was further observed that, whereas the lime sugar showed a distinct stickiness and possessed the musty stale smell peculiar to raw sugar stored for some time, the "Clarite" sugar, to the contrary, had the pleasant fresh smell of recently-made raw cane sugar. According to the author, this great advantage of producing a sugar of such excellent keeping quality entitles the "Clarite" process to extended careful analysis in the Queensland sugar mills.

The Rôle of the Pre-Evaporator in the Manufacture of Sugar, especially White Products. *By J. Wiesberg. Sucr. Belge, 1910, 38, 565-567.*

This article is a *resumé* of the opinions of different experts on the value of the pre-evaporator (*cuiseurs de jus, Vorkocher*) from the point of view of its possible influence on the quality of the sugar. Dr. Gærtner stated recently that he considered that the use of pre-evaporators was harmful to the quality, and especially to the appearance, of the sugar, on account of the high temperature to which the juice was submitted in this apparatus. It is possible, he added,

to effect the same economy of fuel by other, less dangerous means. Dr. Kœhler, however, believes that it is not the pre-evaporator itself that injures the quality of the sugar, but that the manner in which defecation and carbonatation have been operated may primarily be the cause. Then E. Saillard, the French specialist, writing on the question has pointed out that factories making white sugar must be more cautious regarding heating their juices to a high temperature than those making low-product sugar. A temperature of 106-108° C. is not considered dangerous, but above this the destruction and decoloration of sugar may be feared, more particularly in the case of juices of low saccharine content, say 10 to 15 per cent. Finally, Pellet has stated that when sulphited beet juice is heated in pre-evaporators to a high temperature and for a long time, reducing sugars are found in the molasses, this pointing to destruction of sugar. The author suggests that it would be of great value for sugar factory managers to carry out experiments on this question using temperatures higher than 108° C., so as to determine definitely under what conditions destruction of sugar and decolorization may take place. It would also be useful, he adds, to find out whether the economy of fuel effected by the use of pre-evaporators is not much less than the loss caused by their use in turning out an inferior quality of sugar.

Duration of Evaporation. *By E. Saillard. Circ. hebd. Syndic. Fabr. Sucre, 1910, No. 1121.*

It has been stated that the time the juice remains in a quadruple effect may be taken, generally speaking, as eight hours, and that about one hour is spent in the first body. This conclusion is based on figures obtained by the coloration method, which consists in heating the juice contained in a flask in an autoclave until it assumes the same coloration as the juice obtained in the effect, the temperature in both cases of course being the same. It is pointed out by the author that such a method gives results which are too high, since in the flask there is no fall of temperature, and no circulation of the juice, such as occur on the large scale, and also because the heating surface in the laboratory experiment is relatively much smaller than that obtaining industrially. The most simple method for solving this problem is by calculation; and in doing this it is only necessary to know the actual juice contents of the body, and the amount of juice passing out per minute. The latter figure is found from the volume of the juice entering, and from the density of the juices entering and leaving the body. In a factory of 500 tons, the juice entering the first body per minute, at the rate of 120 litres per 100 kilos. of roots, taking 1440 minutes in the day (24×60), is: $\frac{120 \times 5000}{1440} = 416$ litres. Knowing the density of the juices entering and leaving, we then have as the amount of juice

leaving per minute: $\frac{416 \times a}{b}$, in which a and b are the percentages of apparent dry substance in c.c. of the juice entering and leaving respectively. Finally, on dividing the actual juice contents of the body by the juice leaving per minute, the average time the juice remains in the body is obtained. The results thus found do not take into account the question of incrustation, which, of course, tends to decrease the rapidity of evaporation and consequently to increase the duration of the juice in the body of the effect.

LIMIT OF PRESSURE AND TEMPERATURE AT WHICH SUGAR JUICES MAY BE BOILED IN THE MULTIPLE EFFECT. *By M. Zujew. Zapiski; through D. Zuckerind., 1910, 35, 944-945.*

With the object of ascertaining the maximum temperature to which sugar juices may be subjected during evaporation, the author has carried out a series of experiments in the laboratory of the Charkow Technical Institute, using first and second carbonatation juices, carefully prepared from beets of high purity and sugar content. The juices were heated in an autoclave, provided with thermometer and manometer, and determinations of the polarization, dry substance (by the refractometer), purity, reducing sugars, alkalinity, and colour were made, before and after boiling. It was found that after boiling 5 minutes at 132° C. and 22 lbs. no reducing sugars were formed; but that after 10 minutes, and the same conditions of temperature and pressure, the reducing sugars formed were 0·003 per cent. In a second series of experiments, in which the duration of boiling was 10 minutes, it was observed that at 112° C. and 7 lbs. the content of reducing sugars was 0·018 per cent., but that the sucrose content had not altered; at 120° C. and 15 lbs. the reducing sugars were 0·015 per cent., with no alteration in the sugar content; at 134° C. and 30 lbs. the reducing sugars were 0·016 per cent., and the sucrose had decreased to a slight extent; but at 144° C. and 45 lbs. the content of reducing sugars was 0·020 per cent., and the sucrose had decreased by 0·12 per cent. The general conclusion arrived at, as a result of these experiments, is that in the first body of the effect boiling may be carried on without fear of loss of sugar provided the temperature and pressure be maintained below 134° C. and 30 lbs. respectively. In an editorial note appended to the article it is pointed out that similar investigations made in German and Austrian factories have shown that 125° C. is to be regarded as a suspicious temperature, and that 138° C. is dangerous.

BEHAVIOUR OF AQUEOUS SOLUTIONS OF SUCROSE ON HEATING. *By M. I. E. Douschsky. Westn. Sak. prom.; through Bull. Assoc. Chim. Sucr. Dist., 1910, 28, 406-407.*

Herzfeld, in his important researches on the amount of decomposition taking place on heating sucrose to a high temperature for a long

time, dealt with concentrations from 10 to 50 per cent. In now continuing this work, the present investigator uses concentrations of 50 to 75 per cent., and heats the solutions in glass vessels hermetically closed, to temperatures from 80 to 135°C., for one hour. So as to obviate the formation of small amounts of acid, which would thus cause inversion, and give too high results, the sucrose solutions were made slightly alkaline with caustic soda. In the original article a large number of tables are given, of which the following, representing the loss of sugar per 100 parts originally present, under atmospheric pressure, at different temperatures, for one hour, are the most interesting:—

Temperature in °C.	50 per cent.	55 per cent.	60 per cent.	65 per cent.	70 per cent.	75 per cent.
80	0·0260	0·0260	0·0230	0·0200	0·0170	0·0170
90	0·0260	0·0490	0·0350	0·0280	0·0170	0·0350
100	0·0510	0·0710	0·0350	0·0350	0·0350	0·0510
105	0·0752	0·0752	0·0878	0·0878	0·0752	0·0752
110	0·0878	0·1003	0·1003	0·1003	0·0878	0·1003
115	0·1504	0·1837	0·1337	0·1837	0·1837	0·1672
120	0·3009	0·3009	0·2508	0·2508	0·2257	0·2006
125	0·7021	0·6519	0·7021	0·6018	0·6018	0·7021
130	1·3039	1·2537	1·3039	1·2036	1·1033	1·0531
135	2·1063	1·9057	1·7051	1·6549	1·8556	1·7051

It yet remains to be seen to what extent these laboratory figures are applicable to the boiling of syrups in the sugar house.

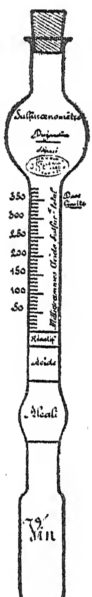
SULPHITATION OF JUICES AND SYRUPS. *D. Zuckerind., 1910, 35, 706-709.*

At a recent general meeting of the *Verein* an interesting discussion took place on this question, in which it was unanimously decided that the sulphitation of juices was disadvantageous on account of the deposits forming in the pumps and in the evaporators, the removal of which presents considerable difficulty. For this reason it was agreed that it is more preferable to sulphite the syrups. One of the speakers, Dr. Zscheye, pointed out that evidently the sulphitation of syrups produced a modification of raw sugar, for now there are no longer complaints as to the difficulty of washing the sugars or of their grey colour, as were frequently heard when the sulphitation of juices was general. This change in quality, it was contended, is to be attributed to the decomposition of iron glucinate: a soluble salt, bluish-violet in colour, which is capable of becoming transformed into an insoluble iron compound. It is, therefore, advisable always to sulphite the syrup and not the juice, using lime, which has a purifying and decolorizing effect on the finished sugar. Sulphurous acid acts on the organic salts that cause the alkalinity of unsaturated syrup, and transforms them into alkaline

sulphates; it combines at the same time with the organic acids that are set free, and converts them into colourless compounds. Other speakers pointed out that the sulphitation of the syrups sometimes causes trouble in the filter-presses, but that this could be obviated by the use of sand filters, which always work well.

SIMPLE AND RAPID METHOD OF ESTIMATING SULPHUROUS ACID, FREE AND COMBINED, IN JUICES AND OTHER SUGAR FACTORY PRODUCTS. *By H. Pellet.* *Sucr. Belge*, *1910*, *39*, *152-154.*

The use of sulphurous acid is gradually becoming extended in sugar factories, both cane and beet. Until recently it was thought quite sufficient to determine the action of the sulphurous acid by directly titrating the acidity, without estimating the actual amount of the free and combined acids in the different products. In this connection the author draws attention to the rapid and simple method of estimating sulphurous acid by means of the Dujardin "sulphuro-œnometric" tube (illustrated in the accompanying figure), at present largely used for testing wine in France and other countries, and believes that it may be introduced in the *sucrerie* as a practical method of examining the sulphitation of the various products. In using the tube, which is first placed vertically in a suitable support, the liquid under examination is poured in to exactly fill the space marked *vin*, then a standard solution of potash to fill the *alcali* division, after which the liquid is mixed and allowed to remain at rest for 15 minutes. Now an acid solution is added, up to the third line, filling the *acide* space, and next to this the starch indicator up to the top of the *reactif* division. Then the titration with standard iodine is carried out, the tube being placed over some white paper to facilitate recognition of the colour-change. When the blue colour appears, the addition of iodine is stopped, and it is then only necessary to read, without making any calculation at all, the sulphurous acid content of the sample tested in mgrms. per litre. As precautions and suggestions in applying this simple method to sugar factory products, it is pointed out that it is necessary to make certain that the non-sulphited juice, &c., does not itself absorb the iodine to any appreciable amount, but generally this will be found to be so. Sometimes, however, sulphur compounds may come from the carbonic acid, *e.g.*, sulphurous acid, or from the lime used in tempering, *e.g.*, sulphuretted hydrogen, so that for these an allowance must be made. After some experiments with the process, the author thinks that the procedure indicated above may be made even more simple by adding only one or two drops of acetic acid to the liquid in the first division, and making up with water to the second mark, that



is by replacing the potash and water acid by water, then adding the starch, and continuing the estimation as described. In the case of very dark-coloured products, in which a direct determination cannot be made, it is necessary to have recourse to distillation, and for this a special apparatus* is recommended.

Raffinose Questions. *By A. Spakler. D. Zuckerind. 1910, 35, 687.*

In connection with this subject the author, who is the manager of a German refinery, raises three questions: (1) whether the occurrence of raffinose is to be regarded as a consequence of the method of working now in vogue; (2) to what extent raffinose occurs in the sugar emanating from single factories, so that it may be indicated whether conditions of cultivation play a part; (3) if the inversion method is sufficiently accurate for commercial purposes. To the first two no definite answer can be given. Still, it is pointed out that according to modern views raffinose originates in the plant, for it has not yet been proved that the galactose group (typical of raffinose) can originate from galactose-free juices. Although this may be so, there arise in the factory compounds that influence the determination in the same way as raffinose itself. Figures are given showing that during the period 1903 to 1909 the "raffinose content" of raw sugars has gradually risen from 1·1 to 1·4 per cent. The third question is very important. In answer to it the author gives analyses of 55 samples of molasses showing that there were differences between the results of two independent chemists below 0·20 per cent. in 21 cases, of 0·21 to 0·50 per cent. in 19 cases, of 0·51 to 0·70 in 10, of 0·71 to 1·00 per cent. in 3, and of 0·71 to 1·01 to 1·4 per cent. in 3 cases. Some other figures are quoted indicating that for a period of 7 years the average difference between two commercial analysts was 0·4 for direct polarizations, and 0·46 for the inversion readings. It is thus seen that in the determination of raffinose by the ordinary inversion method no great discrepancies are involved, the manipulation of the direct reading apparently not introducing any greater source of error than the direct polarization.

Properties and Determination of Raffinose. *By A. Herzfeld. D. Zuckerind., 1910, 35, 830-832.*

It is pointed out that the interest taken in raffinose became largely lost with the disuse of processes of desaccharifying molasses, but was again aroused when, some years ago, last-products were suddenly found to contain it in larger amounts than before. As to its determination,

* Both the tube and distillation apparatus as well as the standard solutions are obtainable from the firm of J. Dujardin, 24, Rue Pavée, Paris, who publish an English catalogue of much interest to sugar factory chemists.

a large number of methods have been proposed. In Tollens and Creydt's mucic acid process there is a possible error of 0·3 per cent., but this in low products is probably greater, besides which the method is too tedious for commercial work. Scheibler's method of precipitation with absolute methyl alcohol depends on the fact that raffinose is fairly soluble in this solvent, whereas sucrose is not; but neither this nor the Gunning modification of it is practical, being complex, and requiring a large amount of material. This same remark applies to the process involving machining-off the syrup, washing the crystals with water, treating the spun-off liquor with strontia, and finally examining by means of the inversion method. Much interest has been taken in Neuberg's emulsin method, in which it is proposed to hydrolyse the raffinose to galactose and sucrose, the former being determined by Fehling's solution. This method, however, is too lengthy and costly for ordinary purposes. In another method of Tollens, treatment is carried out with naphtho-resorcinol, followed by a spectroscopic examination; but it is only suitable as a qualitative test, since levulose interferes with the quantitative determination. Finally, the author mentions Andrlik's method of obviating the optical effect of the amino-acids, in which the direct polarization is made in a solution acid to HCl, urea being added to retard inversion. None of the above methods are of sufficient rapidity for commercial work, so that the use of the inversion method and raffinose formula must be retained. It is suggested that it may be possible to find a hydrazone of melibiose capable of being precipitated from the inverted solution.

Determination of the Ash Content of Raw Sugars, Massecuites, and Syrups by the Electrical Conductivity Method. *By A. Trenkler. Österr.-Ungar. Zeitsch. Zuckerind. Landw., 1910, 39, 423-441.*

For determining the ash in a large number of samples, such as occur in the daily routine of a sugar house, Main devised an electrical conductivity method, which was stated to be both accurate and rapid (*vide* this *Jl.*, 1909, 334). Lange examined this method, and confirmed the claims as to accuracy and rapidity, but at the same time proposed a modification, applicable to a wider range of products (this *Jl.*, 1910, 423). Now the present author states that for some time past he has used the electrical conductivity method in the Aussig Refinery, and has found it to give exceedingly concordant results, provided the necessary constant be correctly determined. He, however, considers that the new method should not be used for estimating the rendement of raw sugars, since this can be found very simply and accurately by the "sulphuric acid" method, *i.e.*, by the ordinary gravimetric determination. It is considered that the special advantage of the

electrical method is that it permits of the rapid determination of the water-soluble ash, which, as usually carried out, is a slow and tedious operation, and on this account but little used in practical routine work. It is also pointed out that a knowledge of the soluble salt content may be of some value in practice, as, *e.g.*, in the control of the crystallization of the massecuite, and for indicating the molasses-forming properties of the soluble salts. A table of results is given showing that in both first and after-products the electrical determination agrees almost exactly with the value found in the ordinary way. The necessary apparatus—induction coil, resistance box, cell, telephone, &c., may be obtained of the firm of Lehmann & Co., Vienna.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E. Chartered Patent Agent, 6, Lord Street, Liverpool; 77, Market Street, Bradford; and 285, High Holborn, London.

ENGLISH.—Applications.

28874. G. Fletcher & Co., Ltd., R. J. G. F. Finney, and R. H. H. Marsh, London. *Improvements in the control of outlet-valves for vacuum pans and other vessels used in the treatment of sugar, and other substances.* 12th December, 1910.

28958. D. L. V. Browne, London. *New or improved method and/or means of treating sugar.* 13th December, 1910.

ENGLISH.—Abridgement.

25246/09. A. Boivin, Paris, France. *Improvements in or relating to machines for breaking and packing sugar.* 2nd November, 1909. This invention relates to a machine for breaking and packing sugar, comprising a breaker, a feed device for conducting the loaves to the breaker and a boxing device for arranging the pieces in packing boxes, characterized by the fact that the boxing device comprises a table upon which the pieces leaving the breaker are arranged one after the other, and a conveyor adapted for conveying together a row of pieces of variable number from this table into a box, and by the fact that the operation of this conveyor is regulated by a counting disc which is actuated by the breaker in such a manner as to advance to the extent of a division at each stroke of the breaker and which carries engaging cams at predetermined intervals in such a manner that each cam engages the boxing device at the end of a given number of strokes of the breaker, that is to say, of pieces on the table, which enables rows of different lengths to be boxed.

GERMAN.—ABRIDGEMENTS.

227430. JULIUS KANTOROWICZ, of Breslau. *A process for making strongly adhesive substances forming a paste in cold water from potato flakes and the like.* 22nd May, 1909. This process is for making strongly adhesive substances forming a paste in cold water from the dry products of potatoes and other amylaceous parts of vegetables, also from flour or starch flour, which is obtained in flocculent form by drying on surfaces heated beyond 100° C., and consists in these flakes being mixed in a manner which is already well-known for substances containing starch flour, with alkaline or acid reacting chemicals, with substances which easily give off oxygen (for instance, superoxides), with chemicals which freely liberate oxygen (for instance, chloride of lime) or with hygroscopic substances.

227606. ADMINISTRATION DER MINEN VON BUCHSWEILER AKT. GES., of Buchsweiler, Lower Alsace. *Process for making soluble starch.* 14th March, 1909. Ordinary starch is treated with air in an acid liquid and the improved process consists in adding before or during the injection of the air catalytic substances such as copper, iron, nickel, cobalt, and the like, salts.

228289. LEON DAUTREBANDE, of Daussoulx, Belgium. *Process for making a permanent aud easily grated dry product from sugar beet.* 27th April, 1909. The washed stripped roots are first exposed to the action of a hot air current in order to loosen the skin, and then, after being disintegrated and dried, subjected to a sudden cooling and finally sifted, so as to remove the particles of skin which have been loosened.

NOTE.—Copies of all published specifications with their drawings in these lists can be obtained from W. P. Thompson & Co., 6, Lord Street, Liverpool, at One Shilling each copy for English or American Patents, and Two Shillings for German. In ordering please give number and date.

Estimate of Principal Cane Crops of the World.

(From J. W. de Silva & Co.'s Report.)

		Crop made.	1910-11.	1909-10.	1908-09.	1907-08.
Chief Countries supplying Europe and America.	Java	May-Nov..	1,200,000	1,290,000	1,266,000	1,240,000
	Reunion	Aug.-Jan..	35,000	40,000	37,000	39,000
	United States..	Sept.-Jan..	300,000	330,000	370,000	352,000
	Peru	Oct.-Feb...	140,000	150,000	140,000	160,000
	Brazil	,, ,, ..	260,000	270,000	240,000	220,000
	Demerara	,, ,, ..	100,000	100,000	110,000	100,000
	Surinam and Venezuela..	,, ,, ..	15,000	16,000	15,000	15,000
	Hawaii	Dec.-April.	490,000	480,000	477,000	465,000
	Mexico	,, ,, ..	150,000	150,000	130,000	115,000
	Cuba	Dec.-June.	1,750,000	1,800,000	1,514,000	960,000
	Porto Rico....	Jan.-June..	320,000	308,000	240,000	190,000
	St. Domingo and Hayti.	,, ,, ..	70,000	69,000	62,000	50,000
	Trinidad and Tobago ..	,, ,, ..	50,000	55,000	55,000	48,000
	Barbados......	,, ,, ..	40,000	36,000	13,000	30,000
	Jamaica	,, ,, ..	10,000	7,000	5,000	12,000
	Antigua and St. Kitts..	,, ,, ..	20,000	25,000	22,000	20,000
	Other British West Indies	,, ,, ..	7,000	8,000	8,000	8,000
	Martinique	,, ,, ..	40,000	40,000	40,000	39,000
	Guadeloupe ...	,, ,, ..	40,000	40,000	36,000	35,000
	St. Croix......	,, ,, ..	15,000	15,000	14,000	13,000
	Central America	,, ,, ..	15,000	15,000	14,000	15,000
	Total Tons		5,067,000	5,244,000	4,808,000	4,126,000
Countries consuming own productions, or exporting chiefly to East.	Argentina	June-Oct...	140,000	130,000	164,000	109,000
	Australia and Fiji	June-Nov..	250,000	220,000	235,000	280,000
	British India..	Dec.-May..	2,100,000	2,125,000	1,900,000	2,050,000
	Egypt	Jan.-June..	50,000	50,000	48,000	60,000
	Formosa	Dec -June..	200,000	160,000	125,000	80,000
	Mauritius	Aug.-Jan..	200,000	235,000	191,000	170,000
	Natal	,, ,, ..	70,000	63,000	35,000	34,000
	Philippines....	Nov.-Mar..	160,000	130,000	123,000	137,000
	Total of **Cane**........		8,237,000	8,357,000	7,629,000	7,046,000
	Beet—Europe		7,945,000	6,138,000	6,544,000	6,562,000
	,, United States.		445,000	450,000	384,000	440,000
	Cane and Beet		16,627,000	14,945,000	14,557,000	14,048,000

UNITED KINGDOM.

IMPORTS AND EXPORTS OF SUGAR

To End of December, 1909 and 1910.

IMPORTS.

Unrefined Sugars.	1909. Tons.*	1910. Tons.*	1909. £	1910. £
Russia	972·13	93· 9	10,070	1,190
Germany	373,499·18	229,970·	4,193,777	2,640.063
Holland	25,766· 4	20,294·16	291,303	235,1[illegible]3
Belgium	19,499· 7	10,996·	211,025	127,780
France	2,140· 1	430·11	25,248	6,116
Austria-Hungary	100,846·16	57,918· 2	1,106,479	718,809
Java	83,112·11	118,304·11	932,929	1,605,161
Philippine Islands	....	....	....	....
Cuba	1,057·10	96,330·14	9,689	1,371,633
Peru	39,610· 4	46,206· 5	414,600	587,881
Brazil	47,172· 6	51,469· 9	468,526	618,752
Argentine Republic	....	....	....	....
Mauritius	19,346·17	41,739·10	173,389	590,625
British India	3,332·17	8,870·19	30,367	96,674
Straits Settlements	1,467· 6	791· 8	13,585	9,389
Br. West Indian Islands, Br.Guiana & Br.Honduras	61,119·19	78,737· 6	794,806	1,146,400
Other Countries	36,240· 7	119,713· 5	394,894	1,662,830
Total Raw Sugars	815,134·16	881,868· 5	9,070,687	11,418,466
Refined Sugars.				
Russia	29,978· 9	2,288·14	367,777	27,357
Germany	415,724· 4	335,791·17	5,447,741	5,096,587
Holland	118,240·16	118,160·14	1,657,266	1,813,659
Belgium	41,016·12	49,460· 8	582,318	743,855
France	86,642· 4	60,987·15	1,150,343	1,007,694
Austria-Hungary	232,562·	199,465·12	3,145,171	3,102,756
Other Countries	20,207·13	80,706·18	270,591	1,369,115
Total Refined Sugars	944,371·18	846,861·18	12,621,207	13,161,023
Molasses	154,462· 4	155,950·18	678,789	702,995
Total Imports	1,913,968·18	1,884,681· 1	22,370,683	25,282,484

EXPORTS.

British Refined Sugars.	Tons.	Tons.	£	£
Sweden	34·14	9· 8	436	157
Norway	682·18	2,945· 2	9,170	44,570
Denmark	5,368· 3	4,055· 2	68,267	56,113
Holland	3,612·17	3,290·11	51,488	48,418
Belgium	415· 9	470·13	5,921	6,730
Portugal, Azores, & Madeira	1,088·13	1,829· 9	13,715	26,006
Italy	1,022·19	930· 5	12,561	11,655
Other Countries	20,034·10	17,882· 9	308,222	305,595
	32,260· 3	31,412·19	469,780	499,244
Foreign & Colonial Sugars				
Refined and Candy	738· 1	1,159·19	11,966	19,178
Unrefined	3,206·13	19,401·15	40,294	238,239
Various Mixed in Bond	32· 6	75·	423	1,285
Molasses	321·13	364· 7	2,301	2,518
Total Exports	36,558·16	52,414·	524,764	760,464

*The figures to the right of the decimal point in this Table represent *cwts.* and not fractions of a ton.

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1910. Tons.		1909. Tons.
Total Receipts January 1st to Dec. 29th.	2,154,715	..	2,050,421
Receipts of Refined ,, ,, ...	149	..	403
Deliveries ,, ,, ...	2,158,065	..	2,064,170
Importers' Stocks, Dec. 28th	None	..	3,350
Total Stocks, Jan. 4th, 1911	50,000	..	71,410
Stocks in Cuba, ,, ...	3,000	..	9,000
	1909.		1908.
Total Consumption for twelve months ..	3,257,660	..	3.185,789

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR FOR 1908, 1909 AND 1910.

(Tons of 2,240lbs.)	1908. Tons.		1909. Tons.		1910. Tons.
Exports	906,013	..	1,443,562	..	1,733,164
Stocks	2,976	..	314	..	....
	908,989	..	1,443,876	..	1,733,164
Local Consumption (11 months).	62,287	..	69,706	..	71,185
	971,276	..	1,513,582	..	1,804,349
Stock on 1st January (old crop)..	9,318	..	....	..	....
Total Production	961,958		1,513,582		1,804,349

Havana, 30th November, 1910. J. GUMA.—F. MEJER.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION OF SUGAR FOR TWELVE MONTHS ENDING DECEMBER 31ST, 1910.

	Imports. 1908. Tons.	1909. Tons.	1910. Tons.	Exports (Foreign). 1908. Tons.	1909. Tons.	1910. Tons.
Refined	940,987	944,372	846,862	798	738	1,160
Raw	734,141	815,135	881,868	18,416	3,239	19,477
Molasses	135,126	154,462	155,951	159	321	364
	1,810,254	1,913,969	1,884,681	19,373	4,298	21,001

	Home Consumption. 1908. Tons.	1909. Tons.	1910. Tons.
Refined	912,010	924,577	823,602
Refined (in Bond) in the United Kingdom........	537,309	599,803	636,751
Raw	113,233	113,762	143,669
Molasses	132,449	141,844	147,638
Molasses, manufactured (in Bond) in U.K........	65,294	67,977	67,969
Total..........................	1,760,295	1,847,963	1,819,629
Less Exports of British Refined.................	26,461	32,260	31,413
	1,733,834	1,815,703	1,788,216

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, DEC. 1ST TO 31ST, COMPARED WITH PREVIOUS YEARS.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1910.
116,600	1,492,470	515,900	718,700	328,400	3,172,070

	1909.	1908.	1907.	1906.
Totals ..	..2,743,410..	3,273,030..	3,096,280..	3,096,850

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING NOVEMBER 30TH, IN THOUSANDS OF TONS.

(Licht's Circular.)

Great Britain.	Germany.	France.	Austria-Hungary	Holland, Belgium, &c.	Total 1909-10.	Total 1908-09.	Total 1907-08.
1898	1299	705	607	229	4737	4674	4533

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1910-1911. Tons.	1909-1910. Tons.	1908-1909. Tons.	1907-1908. Tons.
Germany	2,572,000	2,027,000	2,082,848	2,129,597
Austria	1,600,000	1,257,000	1,398,588	1,424,657
France	750,000	801,000	807,059	727,712
Russia	2,075,000	1,145,000	1,257,387	1,410,000
Belgium	285,000	250,000	258,339	232,352
Holland	225,000	198,000	214,344	175,184
Other Countries	550,000	460,000	525,300	462,772
	8,057,000	6,138,000	6,543,865	6,562,274

THE
INTERNATIONAL
SUGAR JOURNAL.

No. 146. FEBRUARY, 1911. Vol. XIII.

☞ All communications to be addressed to the Editor, Office of "The Sugar Cane," Altrincham, near Manchester. All Advertisements to be sent direct.

☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

Cheques and Postal Orders to be made payable to NORMAN RODGER, Altrincham.

The Editor will be glad to consider any MSS. sent to him for insertion in this Journal and will endeavour to return the same if unsuitable; but he cannot undertake to be responsible for them unless a stamped addressed envelope is enclosed.

NOTES AND COMMENTS.

British Sugar Machinery in 1910.

The Times recently circularized some 250 leading British engineering firms to ascertain how their business had prospered during 1910. Among the replies received and published were several from sugar machinery firms. The Harvey Engineering Company (Limited), Glasgow, wrote that they were well employed during 1910, and have still a fair amount of work in hand. Messrs. John McNeil & Co., Govan, who specialize in the manufacture of sugar-working machinery, stated that during 1910 they were exceptionally well occupied. Their senior partner, who has had 50 years' experience of the trade, says that he remembers no time like it. The prospects for the trade, however, are that the present busy state of affairs will not last much longer owing to the fall in the price of sugar, though this firm has sufficient work work on hand to carry them well into the present year. Amongst the very important work which they executed, and which made a record year of 1910, were large mills for Formosa, Peru, Brazil, Trinidad, Jamaica, Portugese East Africa, Barbados, and Java. Messrs. D. Stewart & Co. (1902) Limited, Glasgow, whose speciality is sugar-milling and evaporating plants, reported a gratifying increase in the number and magnitude of orders placed with them during 1910. The high price of sugar was chiefly responsible for this. Prospects for

1911 are, they say, very promising. Messrs. George Fletcher & Co. (Limited), Derby, remarking upon the extraordinary increase in the consumption of sugar, which has naturally provided a stimulus to both cane and beet growing, said that this result is reflected in the adoption of all the many modern improvements in machinery designed for the most advantageous treatment of the raw material, and they are reaping to the full the benefit of the consequent improvement in trade. With their works equipment modernized and reorganized, they have done good business during the past twelve months, and their prospects for 1911 are exceptionally good. Other firms were mentioned in an article in the same issue dealing with the Scotch sugar machinery trade, some reference to which will be found on another page of this *Journal*.

It is gratifying to learn that the British engineers are holding their own against foreign competition not only in our own Colonies but also in neutral markets, such as Cuba and Formosa. The large influx of orders during the last few months points not only to the wide extension of the cane sugar industry but also to a determination on the part of sugar planters to replace their old plants with more modern machinery and appliances; and this process of substitution is likely to provide work for the engineers for some years to some. American manufacturers are competing keenly with British and Continental engineers for tropical orders; but it is probable they will find their hands fairly full for some time to come in refitting Louisiana sugar factories. They have, however, a big rival in their territory of Hawaii, where the Honolulu Ironworks, under the management of Mr. Hedemann, are laying claim to be classed as among the leading sugar machinery makers of the world, they having secured no mean share of recent Formosan orders.

The most satisfactory feature of all is, however, the growing demand in the British West Indies for modern mills, and, as even Barbados of late has been largely in the market in this respect, we may conclude that the movement towards scrapping the antiquated plant of a previous generation is well on foot and will progress rapidly towards completion.

A Sugar Cartel in Japan.

Reports to hand from Japan suggest that the Japanese sugar industry is passing through an experience identical with that encountered in Germany when the Cartel bounties were at their height. Japan rightly decided some years back to foster the Formosan cane sugar industry, no doubt on the principle that the productions of her dependency had a prior claim on her over those of Java, for instance. But, unfortunately, she seems to have overdone it, and by means of excessive protection fostered the new agriculture in Formosa to such an extent that it has outgrown the home demand. This, of course, is

extremely awkward for the growers on the one hand and the refiners and merchants on the other. So they have put their heads together and are endeavouring by means of monopoly and boycott to keep all foreign sugar out of Japan and then to sell the Formosan product at a sufficiently large profit as to be able to dump the surplus sugar on foreign markets. Their task will be rendered easier after July next, inasmuch as the tariff on sugar imported into Japan will then be raised considerably. Unless we much mistake, it is the story of the Cartel *régime* over again, transferred in this instance to the East. What the participants in the Brussels Convention will say to it all may be awaited with interest, but we hardly suppose they will accept with equanimity any proposal to dump Formosan sugar at cut prices on the European market. And yet it is hard to see how, under the present arrangement acquiesced in by the Brussels Conference, England can be coerced into refusing this sugar if it is offered her; for she has refused to shut out from her market any supplies of sugar, whether bountied or not, and the other signatories have consented for the present to allow this refusal to stand. It is a question, however, if they would consent permanently, supposing a large supply of Japanese bountied sugar were to enter the British market and oust Continental beet. If the Japanese Cartel succeeds, the future is not unlikely to be exciting in the world of sugar.

What is Protection?

A Japanese correspondent who sends us some information on the above subject (reproduced on another page) concludes with the sentence: "We learn that there is a cry in your country to 'return to protection,' but quite the opposite one should be needed in this country." We cordially agree with him as regards his own country, but if by "protection" he means "prohibition" such as Japan is treating her sugar industry to, or such as the United States practises in many of its tariff impositions, then we must give the first part of his sentence an unqualified denial. We have no wish in this country to protect our industries to any such extent that they live by purely artificial stimulation and hold their supremacy solely through a tariff which is prohibitive to any foreign competition. There is all the difference in the world between a system of bounties such as bolstered up the German sugar industry ten years ago, and a preference on home grown sugar of say 2s. 6d. per cwt. But to some people the mere mention of the word "protection" implies prohibitive taxation of all foreign competition; and so well is this realized that it explains why tariff reformers in the United Kingdom avoid the term as much as possible. As showing the unreasonable nature of the assertion that any tariff reform must necessarily imply a "return to protection," the following comparison with a phase of every day life may not be

out of place. A small percentage of the population go so far as to assert that all drinking of alcoholic liquors is wrong and indefensible. The average man, however, sees no logical reason why, because some weak-minded individuals go and make drunkards of themselves, he should be deprived of the option of drinking in strict moderation. And it similarly passes our understanding to know why any educated man can argue that once we introduce some reform in our tariff system it cannot stop there but must end in prohibitive taxation of all outside competition. There is one important reason that would make it stop in time and that is public opinion. And until public opinion decides very plainly on having protection, the latter cannot get any real footing in our fiscal system.

The Cost of Production—A Correction.

In our last issue appeared a note from the pen of Mr. H. C. Prinsen Geerligs on the cost of production of Java sugar. Owing, however, to a slight alteration in the original copy which was not detected in time, Mr. Geerligs' figures were given the wrong significance and the cost of production was in effect understated. The figure of 7s. 6½d. is not f.o.b. Java, but the cost at the buyer's doors at the coast. As all expenses for warehousing, lighterage, loading, &c., are extra, and as moreover the charge for freight does not include insurance, it comes to this that the figure of 7s. 6½d. per cwt. of sugar at the buyer's warehouse is equivalent to 8s. 9½d. in Europe when the rate of freight is 20s. per ton, and to 9s. when the rate is 25s. This increases the c.i.f. price by a little over 3d. per cwt. as compared with the figures given in our January issue. Needless to say, the conclusions we drew therefrom are nowise weakened by this correction, but on the contrary strengthened, as 3d. per cwt. is no small margin in sugar prices.

The Spirit Surtax.

Our readers will remember that an article appeared in the August number of the *International Sugar Journal* under the heading of "A Protected Industry," in which it was shown that the spirit surtax constituted a direct protection to the distillers of this country, especially of whiskey, inasmuch as the claims on which the surtax was based were almost entirely without foundation. An interesting development has now taken place, the United States Government (whose attention there is every reason to believe was attracted to the subject by the article in question) after fruitless negotiations with the Government of this country with a view to the removal of the surtax, having decided to impose a countervailing duty of 4½d. per proof gallon on all whiskies imported from the United Kingdom. The amount of the whiskey surtax, that is to say, the difference between the excise and customs duties, is 4d., which we may remark

is a high percentage on the bond value of the article; and as whiskey exported from bond from this country receives the equivalent of the surtax in the form of a direct payment, the United States authorities are justified in regarding this as a bounty and retaliating accordingly. This action should have the effect of breaking down, or considerably modifying, the obstinate attitude which the authorities on this side have assumed in connection with the repeated representations of the West India Committee, acting on behalf of the Colonial rum producers, and at the least have the result of bringing about the impartial enquiry into the matter asked for, and which has been persistently refused.

The West Indian Mail Subsidy.

It is announced that the Royal Mail steamers between England and the West Indies are after all to call at Barbados on their outward and homeward voyages, the Barbados House of Assembly having recently voted £4000 a year towards the mail service. This will be a very satisfactory arrangement for Barbadians; at the same time Trinidad will remain, if we mistake not, the port of transshipment for the intercolonial traffic.

Discussing the new contract (as it was given in our last issue) the *West India Committee Circular* of January 17th remarked: "While it would be ingratitude to attempt to minimise the value of the Imperial contribution, which will, it is understood, amount to £40,000, it is, of course, Trinidad's splendid offer of £20,000 which has rendered the present arrangement possible, and, in the circumstances, the neighbouring colonies will not, we imagine, grudge her the position which she will now occupy of headquarters and port of transfer of the intercolonial steamers. British Guiana and the Windward and Leeward Islands have also come forward with offers as generous as their means allow, and at the time of writing there is good reason to hope that the new House of Assembly in Barbados will also vote a sum of money sufficiently adequate to ensure that that island shall not be left out in the cold, as it might otherwise be. Throughout the entire negotiations, the Colonial Office and the Post Office have evinced the keenest desire to bring about a settlement acceptable to the colonies concerned, and it must not be forgotten that the Royal Mail Steam Packet Company have also approached the matter in a generous spirit, and by concessions at the eleventh hour helped to bring about the very satisfactory result of the negotiations, in which the West India Committee also took a prominent part. The matter is certainly one for general congratulations."

The Cost of Experimental Work in the West Indies.

In the course of a recent lecture at the Royal Colonial Institute on the Agricultural Development in the West Indies, Sir Daniel Morris,

K.C.M.G., said that the average expenditure on scientific investigations of matters directly affecting the sugar industry at Barbados, Antigua, St. Kitts, and British Guiana was at the rate of nearly £4000 per annum, and the results of the sugar experiments carried on have proved of great service to the planting community in the West Indies, and they have also been shared in by other countries, such as the Southern United States, Australia, Natal, and Mauritius. It is estimated that fully one-half of the canes now cultivated in the West Indies are new canes yielding over large areas mean results ranging from 10 to 25 per cent. higher than the older varieties. The total annual production of sugar in the West Indies is about 240,000 tons, of the value of about £3,000,000. In recent years an increasing amount of sugar and molasses has been shipped to Canada. In 1897 the Dominion took 11,000 tons of sugar, but in the year 1909 it took a total of 133,000, or about 60 per cent. of the total production.

BEET SUGAR GROWING IN ENGLAND.

Progress of the Movement.

"There is no likelihood of a sugar factory being built anywhere in England this year." Thus was the situation summed up by a well-informed correspondent of *The Times* a few days ago. This news is most unfortunate; but it was only what careful observers had feared for the last month or two; and the causes that have led to this failure are not hard to find. It may be taken for granted that the chief one is the present low price of sugar, which makes it difficult for a new industry to start on a successful career, seeing that during the first year or two expenses will be bound to exceed the average, and therefore it is not possible for either farmers or manufacturers to be sure of making a profit. The farmers have therefore been slow to sign contracts, and the manufacturers have been cautious about accepting them. And meanwhile time has flown, and, even in the case where preliminaries have at length been satisfactorily concluded, there is now no chance of a factory being erected in time for the approaching autumn crop. Hence everything has to be shelved for at least another year.

With regard to the Essex experiments, we learn an unfortunate *contretemps* has arisen. Two of the three English directors of the East Anglia Sugar Company have resigned, they having rightly or wrongly come to the conclusion that the chance of establishing a beet industry in Essex in the immediate future is too remote. This opinion is based no doubt on a good knowledge of the local attitude; but the immediate factor that has contributed to it is manifestly the disheartening result of the 1910 experiments. As *The Times* correspondent puts it, "owing partly to adverse weather, which was responsible

for the seed being sown a month late, and partly to other causes, such as the inexperience of the growers, the lack of attention given to the beets in many cases, and the heavy cost of harvesting, due to the sticky state of the land, the crop was a disappointing one financially. It is doubtful if it exceeded 7½ tons an acre. The large quantities of dirt put into the railway wagons along with the beets were the cause of heavy deductions by the factory, payment being made in accordance with custom, only on net weight."

It was no wonder then that the prospects of a large acreage being grown with beets in 1911 were poor; and this has doubtless convinced Messrs. Strutt and Hasler that no good can be gained by remaining on the board of the Company. Be that as it may, it is rather a pity they should have resigned so soon.

Needless to say, with the failure of the Anglo-Dutch venture in Essex, the chances of a successful start being made in the near future in this country are greatly lessened. It is hoped, however, that the Hummelincks may be persuaded to co-operate with the gentlemen who are planning a factory at Sleaford in Lincolnshire, in which case there would be a chance of starting a factory there in 1912.

A new company has been formed just lately to start a sugar factory near Kidderminster. It is styled the Worcester Beet Sugar Company, Ltd., and the first directors are Sir Sidney Lee, Bart., Mr. C. Dalley, J.P., and Major E. A. Knight, M.P. Several Liverpool gentlemen, including Mr. Sigmund Stein, are interested in the venture. The capital is fixed at £100,000 in £1 shares, and the minimum sum on which they will go to allotment is £60,000. But the latest advices state that there is no prospect of the factory being erected this year, as the machinery manufacturers cannot guarantee installing the plant in time for this year's crop. So the farmers have been asked to carry forward their contracts for another year.

During the past month the National Sugar Beet Council, of which Lord Denbigh is Chairman, has issued its Report on the experimental beet crops grown in 1910 in various parts of England. Information had been invited from the various growers as to the results of their experiments, and replies relating to some 260 plots varying in size from a quarter-acre to 24 acres were received. The Report states:—

"Full returns and samples for analysis were received from about 75 growers. In addition to these, 50 plots of a quarter of an acre each were grown in Herefordshire, where the local Advisory Committee tabulated and published their own results. The sugar contents of these latter were very encouraging, averaging 17 per cent., and the weights per acre, so far as they can be accurately judged from these small plots, were excellent, averaging about 19 tons per acre.

"It is also very valuable to note the fact that in many other varied districts of England roots have been grown with excellent results, showing high percentages of sugar and good tonnage returns, not

only in small experimental plots, but, in some cases, crops of several acres. As evidence of the above the following instances may be mentioned:—

	Per cent. sugar.	Tons per acre.
Berkshire, Wallingford	17·0	14½
Cornwall, Marazion	17·3	26½
Essex, Dunmow	18·7	14¾
Gloucester, Staunton	17·1	—
Kent, Canterbury	17·1	15¼
Middlesex, Harlington	17·7	16¾
Somerset, Bridgwater	18·3	15¾
Somerset, Yeovil	17·7	15
Somerset, S. Petherton	17·3	17½
Suffolk, Bury St. Edmunds	19·1	13
Suffolk, Ipswich	20·5	—

"So far as any conclusions can be drawn from the full analyses, it would appear that the coefficient of purity is lower on clay or very heavy loam than on lighter soils; in fact, some of the best results in this respect were obtained on sandy or gravelled loams. A reason for this may be that the very heavy soils are seldom cultivated deep enough in this country, and it is probable that if such soils were broken up to a foot or more in depth, and well dressed with the factory lime waste, great improvement would result, as the beets would grow downwards, be better shaped, and have their crowns well covered with soil.

"It seems to be shown fairly conclusively that sewage farms and irrigation with sewage produce beets poor in sugar and containing juice of low purity. A judicious use of superphosphate and nitrate of soda improves both quantity of sugar and quality of juice, but the generally somewhat haphazard nature of the cultivation, as indicated by the tables, makes accurate judgment difficult. It is most important that beets be grown on the flat and not on ridges.

"A large proportion of the area grown was in Lincolnshire, and some of the roots were exported to Holland; but, unfortunately, full cultivation returns were not obtainable from the growers of exported roots. However, the analyses of roots from this county as made by Mr. Ling showed results of 16·3, 16·5, 16·9, 16·7 and 16·9 per cent. of sugar. The weights grown by one group of fifteen growers in Lincolnshire show an average of 15½ tons of cleaned roots per acre, which is better than in some other districts, but as we have no report from our analyst on these, either as to sugar contents or size or shape of roots, we can assume nothing.

"From information supplied by the factories to which roots were exported, it is ascertained that those from Lincolnshire yielded about 15·4 per cent., and those from Essex 18 per cent., of sugar It must be remembered that these Dutch analyses were taken after the roots

had travelled under very unfavourable conditions on board ship, and that under these conditions the sugar contents diminish.

"Although, in consequence of the unsystematic and unscientific manner in which the experiments have been carried out this year, no very definite conclusions can be drawn with regard to the technicalities of cultivation, it is still very evident that roots of excellent sugar contents and of satisfactory weight per acre can be grown in various parts of England.

"In order to encourage capitalists to come forward with money for factories they must first be satisfied as to the willingness and ability of the farmers to grow the raw material of the desired quality. Farmers in many districts at present are hesitating, as they are not convinced with regard to the costs of cultivation and delivery. The factors could not be satisfactorily determined in the absence of any market for the beet, without which farmers would not, naturally, grow more than small quantities.

"Dutch manufacturers have, therefore, conferred on us a signal service by opening a market to all who will grow roots pending the erection of factories in England. The charges for freight preclude growing for export from any localities except the Eastern Counties, and it is, therefore, to be hoped that financial assistance will be forthcoming whereby certain approved farmers in selected districts, who would undertake to grow ten-acre experimental plots, may be guaranteed against loss.

"The Council was without any regular funds, and was only able to undertake the work which it did this summer through the generosity of some friends who were interested in the movement, and it was hoped that later on it would be possible to get something from the Development Fund Commissioners to carry on the work.

"So far, however, the Board of Agriculture is not disposed to recommend this course of action, and seems to consider that the educational work could be better carried out by the Board. It appears to the Council that educational work systematically carried out and done in a practical manner is what is urgently required at this juncture, and if a Government Department with its greater weight and authority, will take up this work, as has been done by the Governments of foreign countries, so much the better. Official Government recognition of the importance of the beet sugar industry, and of the immense good which it would confer on British agriculture, would be a great encouragement to that investment of capital in factories, without which no real progress can be made.

"It may by now be said to be conclusively proved that the British climate is entirely favourable to the production of roots of high sugar content and satisfactory purity. All that is required for the

establishment of a new and profitable industry that would have far-reaching and beneficial results to the country is the necessary capital for factories, coupled with careful organization and technical experience."

On February 7th Lord Denbigh again broached in the House of Lords the question of the Government encouraging the beet sugar industry; but the answer of the Board of Agriculture was that no grant could be made out of the Development Fund to any company trading for profit; and as to the alternative of retaining the import duty on sugar and giving pledges not to impose for several years any corresponding excise duty on sugar produced in this country, the Government considered this a policy of dry-nursing an infant industry with which they would have nothing to do.

THE SUGAR BEET.*

Its Mode of Cultivation and Development.

By Ed. Koppeschaar.

(Continued from page 15.)

IV.

Diseases and Enemies.

The sugar beet is specially prone to animal and vegetable parasites. When entering at some length into the causes that lead to disease, it is, of course, not our intention to unduly alarm the would-be grower (the list of beet pests being a long one). But in order to cope with all possible troubles that may befall the beets when germinating and growing, we must anticipate everything a farmer is likely to encounter in this respect. If United States experience counts for anything, it is very probable that British beet fields will not remain permanently free from attacks of disease and insect pests. Therefore, while keeping within the scope of these articles, it is advisable to make some mention of those diseases which are capable of causing serious injury (in fact, may cause the experiment to end in a financial loss for the grower), and indicate the steps to take to eradicate them; what is more, to point once more to all those details which will tend to prevent them, bearing in mind that prevention is better than cure!

With a crop like beets, where the yield per acre will strongly influence the margin of profit for the grower, the farmer should certainly not omit any of the means already indicated in our previous articles to prevent disease putting in an appearance. It may be

recollected that a well-prepared seed bed, good drainage, good manuring, good sound air-dried seed, a well-balanced crop rotation, the exercise of care in keeping down weeds, the admitting of air and warmth to the soil, &c., were all points dwelt on as a *sine quâ non* to healthy growth. Still, assuming that all possible care has been bestowed on our beets, a warm, moist spell of weather may give rise to fungi; or other diseases may develop and get a firm hold, for all of which the following notes may help to prove the truth of the saying that "forewarned is forearmed."

Dividing the various diseases into convenient divisions, we may first treat on: *The damage done by other plants.* That we name *weeds* in the first instance will be readily understood, for a system of cultivation, as already described, in rows, with much open space between, on a well-manured seed-bed, favours the development of weeds.

By weeds we imply all those plants which grow amongst the beets, while not being sown, and whose growth tends to lessen the yield. They need not necessarily belong to an order of wild-growing plants, but may be derived from a crop grown the previous year, which may have left seeds in the soil, brown mustard and clover for instance.

Though possibly superfluous to the genuine farmer we may as well sum up here in brief the harm caused by weeds, the writer having in mind cases of beet fields that should by rights have been named *weed fields.*

1. Light, so much needed by our beets, is partly absorbed by weeds, especially by those possessing a large foliage. 2. The space requisite for development will of course be correspondingly reduced. 3. Weeds will absorb water and food just as well, thus robbing the plants that have a prior right to it. 4. Some weeds will live like an ordinary green-leaf plant, but their roots will intertwine with those of the beets, thus living in part a parasite life. 5. Weeds will serve as cover and breeding place for several harmful species of insect life, thus making more difficult the extermination of these latter. 6. Weeds will sometimes do harm to drain pipes with their roots. 7. Finally they will cause trouble when harvest comes and they form, just like stones, a nuisance to the manufacturer. In the first chapter we pointed to the value of frequent hoeing and weeding; this should commence as soon as the rows of young beets are visible, and the soil between the rows should be kept clean until working is made impossible by the close growth of the foliage.

That it is important that the beet-seed does not contain weed-seeds is evident when it is mentioned that wild camille produces 60,000 seeds from one plant and the wild poppy 50,000. Crop rotation and thorough working up of the soil with proper drainage will tend to minimize this plague.

Next come those plants which are parasites proper; in this class must be included those plants, and living organisms belonging to the plants, which depend for the building up of their cells on either dead or living organic bodies possessing no green colouring matter in their leaves, thus having no workshop to utilize the sun's energy; those most to be feared are fungi.

With some larger representations of these, e.g., the common mushroom, and with the mildew that grows on mouldy old bread, we are all well acquainted, and these represent good examples of this classification.

Of the smaller ones worth mentioning to beet growers, one species causes the much dreaded *rootfire*. As far back as 1812 we find this offender mentioned, so experienced growers have had time to study it. The young seedlings attacked by it show a black spot beneath the first leaves on the young stem, that soon extends towards the root. The root is encircled by a violet-coloured thread-like texture or *mycelium* which enters the beetroot and kills the plant. In this case the sick young plants show brown leaves, until after a *couple of days* the root is dried up entirely and the plant dies off. Older plants are also attacked by it; sometimes they survive but they never grow to be healthy full-grown beets with normal sugar contents. In case they survive, new root hairs are formed, the head root is destroyed and a forky beet is the result.

The means of propagation of these fungi are spores or dust-like bodies, easily spread by the wind, and accordingly occurring anywhere.

Attempts have been made to prevent the appearances of *rootfire* by treating the seed with sulphate of copper—the agency already found so useful for wheat-smut and which together with quicklime forms the Bordeaux mixture, well-known to render splendid service. Treatment of the seed in a solution at the rate of half-a-pound of sulphate (blue vitriol) to 1 cwt. of seed, has given favourable results as compared with not treated seed. But we must not forget that the spores of these fungi occur anywhere in and on the soil, so while leaving no doubt whether the sulphate kills off the spores thoroughly, a faulty condition of the soil will always leave a loophole for fungi development.

Soaking this seed with a solution of Chili salpetre, thus offering abundant, readily available nitrogen food to the seedling (one part to two of water) has also proved effective. In the particular experiment lime had no effect; indeed on the contrary, all sorts of insects and larvae seem to be attracted by it. All things considered, the best prevention is therefore good drainage while the soil is in a good hygroscopic condition (following on a speedy harvest of forecrop and subsequent fall plowing) and plenty of available nitrogen and

phosphoric acid applied; likewise the use of a liberal quantity of sound, quickly germinating seed, and not too sparing a use of the hoe.

The full grown beets are also liable to be attacked by fungi; such beets showing rotten places should not be shipped to the factory, but be thrown away. If handled with a sharp fork or in a careless manner wounds will be made and the roots will then be easier to contaminate.

The accompanying figures of the beet forks, though representing such a simple instrument, deserve a place here. *Fig. 1* shows the right kind of beet fork, the points being stunted by small balls. This fork will not cause wound places, which, besides the danger of offering a foothold to fungi, will cause a loss to the manufacturer. Forks like *Fig. 2* should be avoided. In the beet flumes, the beets as a rule float towards the factory in the so-called fallwater, except when a mammoth pump or endless screw unloads them. This fallwater is formed by the injection water of the central condenser, and has a temperature of 30 to 40° C. [86 to 104° F.]. Floating in this water for several minutes the beets lose only a small fraction of sugar, but here wound places, will, of course augment the loss. The factory should therefore have the right to refuse wounded or partly rotten beets, as they cause serious trouble and loss in the manufacture.

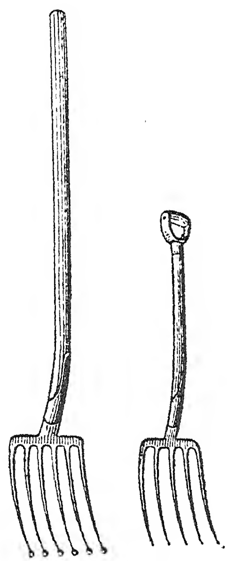


FIG. 1. FIG. 2.

In regard to diseases of *beet leaves*, several sorts of fungi are known to cause harm. *Bordeaux Mixture* has proved effective for combatting them. This simple remedy, known to every farmer, is mixed the same way as when used for potatoes, viz., 1½ per cent. vitrol and ½ per cent. quicklime to 100 water. The lime-milk is made by itself, the sulphate solution also, then the two solutions are finally mixed together. Make 200 gallons at a time, as this is about the quantity a man can apply in a day with the aid of a spray-pump, supplied for this purpose.

Next, we will touch at some length on the diseases and the damage caused by animal life, introducing those which are most to be feared by our readers, viz., the so-called beet worm or nematode, an eel-like parasite, measuring about 1 mm. [0·04 in.] in length. *(Fig. 3.)*

It is an old offender having probably attacked the roots in beet fields as long as these plants have been cultivated. Before its mode of life and habits were studied, however, and the farmers did not know how

their beets came to wither or at least remain stunted, the result of the damage done by this nematode made people speak of the land being "beet-tired." This was not, however, an unapt description, as experience has taught that the nematode always threatens with

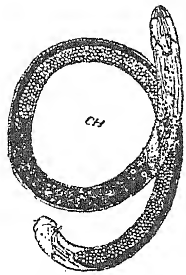


Fig. 3.

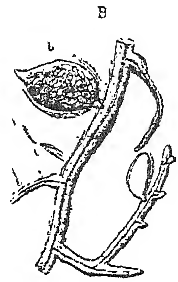


Fig. 4.

destruction when the well-known custom of crop rotation is neglected, and when, against all common sense, beets are grown after beets, year in year out, thus causing favourable conditions for its extraordinarily rapid multiplication.

Only the larvae and the male worms have the long eel shape, the full-grown female worms are swollen and shaped like a pear (*Fig. 4*).

The female worm measuring about ·04 inch in length is found attached to the fine root hairs, which to the naked eye show small white points (*Fig. 4*). It contains on the average 350 eggs, which are hatched within the mother's body. Finally nothing is left of the female but a cover, holding the larvae (*Figs. 5* and *6*). These begin to

Fig. 5.

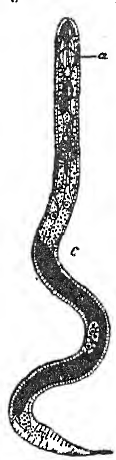


Fig. 6.

slip out, seeking a thick root hair, and boring themselves into it. They live there, parasiting, and thus cause the disease of the plant. Soon after the larvae strips off its old skin and then swells up into a body of a plump form, bending by its growth the epidermis of the root to the outside. Ere long a difference is visible between the male and female forms. The thick motionless larvae, that change into male worms, stop for some time to take up food ; then the inner body draws back from the outer skin, and after a new thin skin has been formed, the developing grub, enclosed by the old skin as in a sack, gradually takes up the form of a thin worm, 1 mm. in length ; this is the full-grown male (*Fig. 3*). He bores himself through his larva skin and through the epidemis of the root hairs, and comes out into the soil where he seeks a female attached to a root hair and fecundates this.

The development of the female worm is mostly as a strongly growing immobile larva ; in time it grows longer and much rounder. Finally the epidermis of the root bursts open and the worm crawls out, but remains attached to the root.

From egg to full growth takes four to five weeks ; six to seven generations may follow each other within a year, fully justifying the taking of such measures as may prevent the pest putting in an appearance. As to the symptoms of its presence, the damages caused by it, and the means of prevention and remedy, the following notes may be found of use :—

Towards the end of July there may be found spaces where the plants show a lighter shade of green. The leaves wither, the outer ones especially grow yellowish and die off. Later on the inner leaves may also die, the beet top gets black, and the whole beet slowly rots away. In case the beets recover, which happens sometimes, they form new leaves in the heart ; but the beets remain small, and develop a so-called beard, being the tangled mass of thin by–roots (a normal beet only shows a thin line of small root hairs, which in well-shaped beets form a spiral).

The result is that sometimes the yield is only *one-third of an ordinary crop ;* it is, therefore, well worth while taking precautionary measures. As already stated, the chief reason in most cases is neglect of rotation. But when we learn that the nematode thrives and lives in about 200 different species of plants, particularly in *oats*, wild radish, mustard, colza, cabbage, we can understand that it may be present even though beets have not been previously cultivated. (See *oats* in regard to rotation, this *Jl.*, December, 1910, page 555.)

A remedy that has proved effective is quicklime ; an application of 900 lbs. to the acre will disinfect the soil. Care should also be taken to clean the tools used on infected land ; even the horses' shoes should be cleaned to prevent infection. The soil that accumulates in the bins of the sugar factory, derived from the soil that adhered to the

roots, now washed off and deposited, contains innumerable beet hairs. This refuse after being exposed to the air for some length of time forms a dressing for the land, but should not be applied to beet fields unless it is disinfected thoroughly and mixed with quicklime.

Another undoubtedly good method to get rid of this pest is the use of decoy plants, as originally advised by Kuhn. A quickly germinating plant offering a favourite food to the worm, *e.g.*, the different cabbage varieties, summer colza, and summer rapeseed, is sown out thick in the infected soil, at a rate of, say, 25 lbs. to the acre. The worms will soon settle in the numerous root hairs of these plants. In order to kill off the worms, the plants must at a certain age be drawn out and left in the sun for a day or two. That this must be done before the worms have left the root hairs is obvious and to determine the right time is the hardest point in the treatment. But after successfully repeating this process several times, the nematode will be for the larger part exterminated.

Another remedy that has proved effectual in the case of oats suffering from attacks of the same pests, is a solution of sulphide of carbon injected into the soil (2 pints sulphide per acre).

The writer recently read in a scientific publication that the nematode had put in an appearance in the United States beet fields; and the suggestion has been made that the pest was imported from Europe in the beet seed. But apart from the fact that the nematode is never found in the seed balls, the beet seed, thrashed off in a wet season, must always be dried either artificially or in the sun, and the nematode in whatever form it may be, cannot survive the drying process, so we can safely discount this theory of the origin of the trouble.

Besides these diseases, the beets have to fear the same insect pests as mangels. One of them, the beet-beetle (*atomaria linearis*), may be specially mentioned. It is a shiny brown insect, ·04 to 0·1 inches in length. It takes up its abode on the tender stem of the seedlings, and causes the death of many young plants. The eggs are found in the beet-tops; thus it is not advisable to leave these on the land (nor the leaves either). They form with beet-tops a fairly good cattle food, when ensilaged, in which case the soil receives back the ash contents in the manure, without any danger of the insects reappearing. A proper rotation and not being too sparing with the seed, is the apparent remedy.

We need not here enumerate all the other insects that are apt to prey on our beets. But as regards some of them, the Department of Agriculture in Austria has declared it expedient to carry out repressive measures, which shows that these pests often do considerable harm. Arsenic solutions, Paris green, *Schweinfurthergreen* (the only effective remedies for the Colorado beetle on potatoes) will all do much useful service in combatting them. A 3 per cent. solution of barium chloride has also been tried with good effect; and the well-known solutions,

kerosene soap, tobacco extract, &c., in their usual application need no further recommendation. Domestic fowls can also be made use of, and in the way of protecting insectivorous birds and small animals, which are friends, not enemies, of the farmer, nothing of course must be omitted.

(*To be continued.*)

THE SUGAR SITUATION IN JAPAN.

The *Japan Chronicle* of December 23rd had a leading article on the present situation in the sugar industry in Japan and Formosa. "During the last few months," wrote our contemporary, "considerable discussion has been going on in regard to the sugar industry, one of the 'infant industries' which has been the object of much paternal care in Formosa. The Government encouraged the cultivation of sugar cane in the island by every possible means, and the production of sugar in Formosa consequently increased enormously. The next thing to be done was to find a market for the product, and sugar refiners in Japan were encouraged to obtain their supplies of crude sugar from Formosa instead of from Java by the excise or consumption tax being removed on Formosan sugar used for refining purposes in Japan. In this way importers of Java sugar had to contend with the competition of the Formosan product, which had the three-fold advantage of a bounty, a discriminatory excise, and a drawback. In these favourable circumstances the production of sugar cane in Formosa increased at such a rate that there was a very real danger that the market would be glutted by over-production, and the authorities, fresh from the task of 'encouraging' the industry, set to work to find a solution for the next problem of over-production. This was solved in an ingenious way; sugar refiners in Japan were offered forward crude Formosa sugar at about Y1 below the current market rate, and as orders were received they were distributed among the various mills in Formosa at about Y1 above the market rate. The authorities acted as brokers between the sellers in Formosa and the buyers in Japan, and the plan appears to have worked admirably—for the Government, the sugar producers, and the sugar refiners.

"The result of this interesting arrangement last year was so successful that it was repeated this year, but the continued development of the Formosan sugar industry under these very encouraging conditions again brought into view a threatened crisis from over-production. The market in Japan for the coarser grades of sugar became glutted, and in order to relieve the situation holders of brown sugar in Formosa agreed not to ship further consignments to Japan

before the beginning of February next, although the usual shipping season commences in December. By this arrangement, therefore shipments to Japan of Formosa brown sugar were to be suspended for two months, in order to relieve the congested market. But apparently even these drastic measures have failed to produce the desired effect, for a few weeks ago the sugar merchants in Osaka and Kobe advised sugar dealers in the interior to suspend the purchase and sale of imported sugar in order to prevent a decline in the price of brown sugar consequent upon the over-production in Formosa. Advice to the same effect was given to the Suzuki firm, who are large importers of foreign sugar in Kobe. It was stated that the consumption last year of foreign sugar, comprising Java white *zarame*, and the Manila and other brown sugar, amounted to 125,800,000 kin, and stocks imported this year and last year still remain on the market. The proposal to stop the importation of foreign sugar was made in order to maintain the market for the Formosan product. The Suzuki firm, however, refused to fall in with the suggestion, on the ground that they saw no reason why they should stop their business, as sugar was legitimate merchandise, and so Suzuki & Co. were accordingly left out of the agreement."

The sequel is briefly as follows. The chief sugar merchants of Tokyo and Osaka have held a conference at which it was decided to take some measures for regulating the supply and demand. Fresh negotiations have been entered into between the sugar companies in Formosa and the refiners in Japan, regarding the disposal of the raw Formosa sugar. These negotiations had not been concluded at the time our source of information was published, but it was expected that a satisfactory settlement would be arrived at. A correspondent who sends us a letter, reproduced elsewhere, dealing with some aspects of this question avers that it is proposed to form a Cartel among the Formosan sugar firms defining the amount of sugar to be supplied to the home market, and disposing of the surplus by dumping it on foreign markets. On the other hand the home market is, if possible, to be protected against the invasion of foreign sugar partly by a high tariff, and partly by a boycott which is being attempted among the Japanese sugar merchants who are being asked to agree to import no foreign sugar whatever into Japan before December 31st, 1911. Thus the Japanese market will be kept as a preserve for Formosan sugar.

Messrs. Manlove, Alliott & Co. Ltd., of Nottingham, the well-known firm of General Engineers, have just received a Royal Warrant of Appointment as Laundry Makers to His Majesty King George the Fifth. The firm in question held a similar warrant under His late Majesty King Edward the Seventh.

AUTOMATIC CONTROL OF CONDENSING WATER.*

By B. VIOLA, Brooklyn, N.Y.

Condensers for vacuum plants, to which this paper is chiefly devoted, employ the wet system of condensation, in which the cooling surface is that of the cooling water during its progress through the condenser.

In practice it is often found that the injection of cooling water is unnecessarily increased at times by incorrect operation of the condensing plant. Besides other visible indications of this mistake, the temperature of the condensed water shows it most strikingly. When too much water is used the work of the air pump is made more difficult because of the air liberated from the water, and if the pump is accurately proportioned for normal operation it is unable to accomplish the extra work. If the pump is large enough, the work is accomplished, but at the expense of additional steam. If a wet air pump is employed, it is called upon to remove an excess of both air and water. Moreover, the excessive injection of water causes a higher pressure in the condenser. Assuming the falling water to be a liquid cylinder, the outer surface of this cylinder upon entering the hot steam takes up the heat of the steam, while the interior parts remain cooler. If, owing to the great velocity of the fall, the water column is unable to effect cooling by the interior portions of the water as well as by the exterior surface, the heat of the discharged water will be too low. But if the equalization of temperature can be brought about through the whole water cylinder during this fall, the cooling power of the water can be utilized more completely.

The more finely the water can be divided in falling the more readily will the gases pass through it and the resistance will be diminished as the surface is increased. The division of the water brings about to a great extent the escape of the air contained in the cooling water. This division, however, is never fine enough; hence in counter-current condensers the real counter flow takes place only upon the surface of contact between water and steam.

Proper utilization of the cooling surface can only be provided for by a proper arrangement of the time of contact. For a freely falling body the time of falling with reference to the height of the fall is

$$t_h = \frac{v}{g} = \frac{\sqrt{2gh}}{g} = \sqrt{\frac{2}{g}} \times \sqrt{h}$$

Theoretically, therefore, the time increases as the square root of the height of the fall, but in the condenser the resistance increases with the height of the fall. Dividing the height of the fall into n parts, we have $h = n\frac{h}{n}$. Giving to the resistance the smallest value

* Read before a Meeting of the *American Society of Mechanical Engineers*, New York.

possible and to the time of heat transfer in the condenser the highest value, the limit of the time of contact of water and heat will be

$$t_{\left(n\frac{h}{n}\right)} = n\sqrt{\frac{2}{g}} \times \sqrt{\frac{h}{n}} = \sqrt{\frac{2}{g}} \times \sqrt{nh}$$

Then for every value where $n > 1$, we have $t_{\left(n\frac{h}{n}\right)} > t_h$

and in general $t_{\left(n\frac{h}{n}\right)} = \sqrt{nt_h}$. If n be taken very large and $\frac{h}{n}$ very small, the time of contact between steam and water in the condenser will be extended proportionately since

$$\frac{h}{n} = \frac{gt^2}{2n^2}$$

It is necessary, however, that the partial fall $\frac{h}{n}$ be not less than the value required by the amount of steam to be condensed. From this calculation it is seen that the velocity of the water is governed by the height of fall, and it is advisable to restrict this height in order to prevent friction resistance, if for no other reason. The smallest value of friction resistance is at $h = 0$, corresponding to the condition when steam and gases flow over standing water. Plants of such construction, however, would be too large. Moreover, water and gases being poor heat conductors when in a state of rest, it is necessary to provide for a certain degree of motion for water in a condenser.

Further, the quantity of steam condensed per unit of time is directly proportional to the cooling surface and a division of the cooling water is therefore equivalent to an extension of the cooling surface.

Therefore to heat condensed water quickly to the necessary temperature by direct contact with the steam, it is necessary (*a*) that the surface of the cooling water be large, (*b*) that the cooling surface change quickly, and (*c*) that the time of contact between steam and water be as long as possible.

To fulfil these conditions a concentric counter-current condenser, such as that shown in Fig. 1, gives the best results. This condenser is designed for use in connection with two or more vacuum pans. By the addition of basins or trays the duration of the contact between water and steam is raised in the ratio of $\sqrt{n}$, resulting in an economy of water. Some water will accumulate in each of these trays temporarily and the temperature is therefore equalized at each stage. The fresh supply of water will sink to the bottom of the tray, forcing the lower stratum upward on account of the difference in temperature, and the warmer water will flow over from one tray to the next. The trays in this manner form zones with the desired small difference of temperature, and constitute a graduated scale from the temperature of the steam admission to that of the gas outlet. The surface of condensation depends primarily on the size of the cooling-water

cylinder when the depth of the trays is greater than zero. It may even be said that these moving water columns promote the cooling, and air and gases will pass at the surface of the trays even though they do not pass at the bottom. During the time the water remains in the trays it has a chance to take up more heat, which is withdrawn from the steam. It is very important that enough water be permitted to flow to secure good results, but by providing the trays with spray holes, the cooling effect of the water is considerably increased.

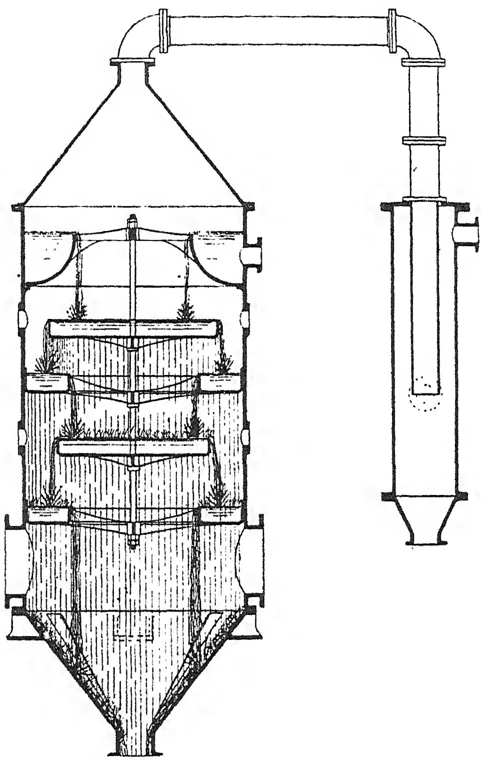


Fig. 1.—Concentric Counter-Current Condenser.

The work of the condenser varies with temperature, but in general it performs about 610 times the work of the air pump, volumetrically speaking. It is absolutely necessary to exhaust the air and gases to promote condensation, but the best air pump cannot do good work with a poor condenser, while a good condenser accomplishes at least fair results with an indifferent air pump.

It is very important that the right quantity of water be used to condense a certain quantity of steam. This matter is neglected in most condensing plants and some kind of automatic device should be applied to regulate the flow of cooling water. Experience has shown that the amount of water should be from 20 to 40 times that of the steam to be condensed. This is a very wide limit and in large condensing plants where immense quantities of cooling water are required some controlling device should be applied from an economical standpoint, so that water will not be wasted.

The first step is to decide at what temperature the water should be discharged from the condenser. This, of course, bears a certain relation to the steam to be condensed. The description which follows is a record of experiments made and results achieved with a condensing plant used in connection with the vacuum pans. I first applied a recording thermometer in the tail pipe of a concentric barometric condenser for the purpose of controlling the cooling water by hand operation of the inlet valve; but it was very difficult to convince the operator of the condenser that it was not necessary to let the cooling water run off cold, because it is generally believed the colder the water the higher the vacuum. After experimenting for some time it was found very difficult to secure good results by hand regulation because of the continuous changes which must be made to meet conditions as the number of pans connected to the condenser is increased or decreased. This led to the application of an automatic temperature controller in the tail pipe connected to the compressed-air inlet valve, by which it was found possible to feed the condenser approximately in proportion to the steam or vapour which had to be condensed, resulting in a better average temperature of the condensed water and only slight variations.

By maintaining a nearly equal temperature of the condensed water, a very uniform vacuum was obtained except at periods when a new vacuum pan was charged. The most striking changes were noticed at 10-30 p.m., 2-45 a.m. and 6 a.m. At the same periods the controlling thermometer showed a considerable fall in temperature, due solely to the temperature of the air drawn in from a newly charged pan which was filled with air at the temperature of the operating room. The vacuum pump draws it into the condenser, as a consequence of which the vacuum drops until all the air is drawn out and the new pan reaches an equilibrium with the vacuum the pump is able to keep up in connection with the other pans. During this period of low vacuum the water is shut off by the controlling thermometer and no cooling water whatever enters the condenser. Since the other pans are boiling, the temperature in the condenser increases until the water left in the trays is raised to the temperature limit, when the controlling thermometer opens the inlet valve and the cooling water is again admitted.

The fact that the higher vacuum is not obtained with an excess of cooling water was shown by the charts. Between 4-45 and 5-15 a.m., when according to the chart the lowest temperature was 110° and the highest 120°, the corresponding vacuum was 25·8 in. Two of the charts showed even higher vacuum with a temperature of 120°, the same vacuum pump and the same number of vacuum pans being used in each case.

The construction and operation of the automatic controlling device by which the foregoing results were obtained are shown in Fig. 2. The

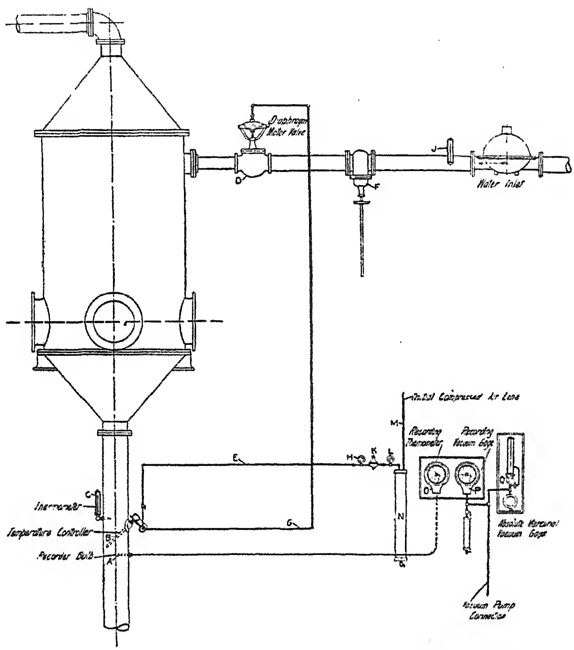


Fig 2.—Diagram of Automatic Condensing Water Control.

stem B expands and contracts in response to temperature changes of the condensed water. The pipe E supplies compressed air of about 15 lb. pressure to the valve mechanism of the controller, from which it passes through pipe G to the water-inlet valve, where it actuates a regular globe valve D by means of a diaphragm motor which replaces the ordinary hand wheel. The temperature of the condensed water affecting the stem of the controller permits all, a part, or none of the compressed air to pass to the diaphragm-motor valve and consequently the latter is very nearly closed, partly open, or wide open according to the conditions prevailing, allowing the proper flow of water to the condenser.

Let us assume that the vapour pipe has been delivering an amount of vapour to the condenser which requires an amount of water that will flow through the inlet valve when the latter is exactly half open. Should more vapour enter the condenser, however, the temperature of the water passing through the tail pipe would, of course, start to rise, but as soon as the controller stem was affected by this higher temperature it would expand and cause the valve mechanism of the controller to allow less air to flow to the water-inlet valve. Consequently this water valve would act to allow more water to pass through and thus maintain the proper proportion between the volumes of vapour and cooling water. The auxiliaries are, *J*, a thermometer to indicate the temperature of the cooling water; *F*, a hand valve for emergency use; *C*, a thermometer to indicate the temperature of the water passing through the tail pipe and serving as a check on the recording thermometer, which has its bulb at *A* and its dial at *O*; and *P*, a recording vacuum gauge, checked by a mercurial absolute-pressure gauge, *Q*. The initial supply of compressed air, *M*, which

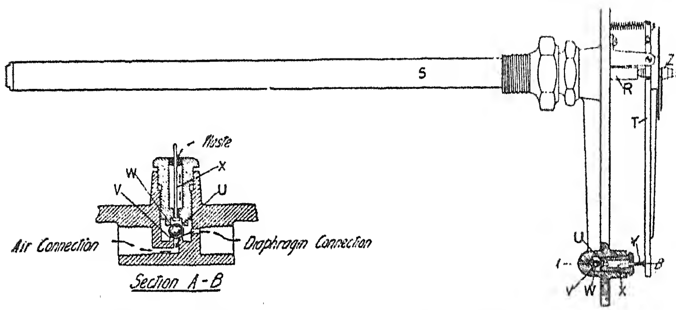


FIG. 3.—CONSTRUCTION OF AUTOMATIC CONTROLLER.

ultimately operates the diaphragm-motor valve on the water inlet, enters the trap *N*, where any moisture or sediment is separated and which also acts as a storage reservoir. Gauge *L* shows the initial pressure of the compressed air supply, which is reduced by passing through reducing valve *K* to the pressure required for the controller, as shown by gauge *H*.

Fig. 3 shows the very simple construction of the controller by means of a section through *A*-*B*. The stem *S* is in two parts, the outer brass tube and the inner rod. The latter is composed of a material which has an extremely low ratio of expansion and therefore remains of almost constant length, regardless of temperature, while the outer brass tube elongates or contracts in response to temperature changes. The tube and rod are so arranged that they are always in intimate though frictionless contact at the extreme end. *R* shows the extension of the inner non-expanding member, which recedes when the outer tube elongates and advances when the outer tube contracts.

The movement thus obtained at R is transmitted by the lever T to the valve mechanism shown in cross section. This is simply a three-port valve, shown more clearly in the section A-B, and all ports are controlled by the one ball W. The first port, V, is the inlet for the compressed air supply; another port, the second, connects with the line leading to the diaphragm-motor valve; the third port is the outlet for the air which has served its purpose by actuating the diaphragm-motor. The position of the ball W depends upon the stem X, which is in contact with the lever T at Y. When extension R moves outward due to the drop in temperature at S, the lever T is raised, and the stem X allows the ball W to leave port V where the compressed air enters. The air can then flow through the second port to the diaphragm-motor valve, which starts to close. If a higher temperature acts upon S, expanding the outer tube and turning extension R inward, lever T forces stem X against ball W. The latter then closes port V, shuts off the air supply, and also opens the third port so that the air can escape from the diaphragm-motor. The diaphragm-motor valve consequently begins to open.

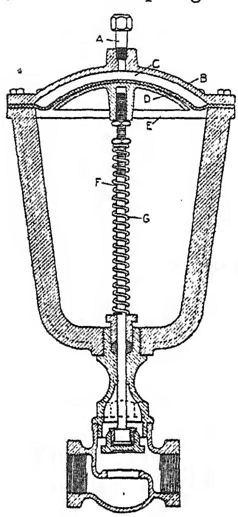


FIG. 4.
SECTION THROUGH
DIAPHRAGM-MOTOR VALVE.

In actual practice, the diaphragm-motor valve is only completely closed or wide open if the conditions are such that the tendency is toward a sudden change in temperature. The controller is so sensitive that the diaphragm-motor valve is constantly throttling, that is, letting in just a little more or a little less water as may be required properly to effect the condensation.

If it is desired to change the setting of the controller, to maintain a higher or lower temperature, it is necessary simply to apply a key to the port Z and, by turning it one way or the other, require extension R to travel more or less before the controller operates.

Fig. 4 shows the diaphragm-motor valve in section. This valve has a regular globe body, with a seat and disc arranged in the usual manner, but with a sliding stem that is operated by the diaphragm motor. The compressed air enters chamber C at opening A. This chamber is composed of a cast-iron top B and a rubber bottom D, called the diaphragm. The air pressure forces the diaphragm downward and the saucer E thus forces the stem F downward while compressing the spring G. When the air pressure is relieved the spring opens the valve again.

This installation has been the means of saving about $400 monthly for over a year in the charges for water which was formerly wasted.

The question arises as to whether, with an equipment as described above, it is possible to attain a cooling-water rate near enough to that called for by theoretical formulae to be economical. Records of the water consumption as determined by meter readings show results very close to theoretical and indicate great savings over the water required with former conditions of operation.

According to the temperature recording charts I have determined the quantity of cooling water by the following formula :—

$$W = \frac{H - h}{t_1 - t_2} \quad \text{in which}$$

W = weight of cooling water in pounds necessary to condense 1 lb. of steam.

H = total heat of steam at condenser pressure and vacuum (can be taken from steam table).

h = heat of liquid of the condensed steam, B.T.U.

t_1 = temperature of condensed water (cooling water and steam mixture).

t_2 = temperature of cooling water.

In average

t_1 = 115° Fahrenheit.

t_2 = 55° Fahrenheit.

H = 1120 (acc. steam table).

h = 115 — 32 = 83 B.T.U.

$$W = \frac{1120 - 83}{115 - 55} = \frac{1037}{60} = 17{\cdot}3 \text{ lbs.}$$

i.e., 17·3 lbs. of water was necessary to condense 1 lb. of steam, which quantity was very nearly correct compared with the effectively evaporated liquid.

In sugar refineries, combined surface and spray condensers are usually employed, which are similar to that shown in Fig. 5. The vapour from the vacuum pan passes the surface condenser first for the reason that in case the vapour carries along some sugar particles, they will be condensed at that point and can be used to dissolve the raw sugar. In this way nothing is lost. The remainder of the vapour passes to the spray condenser, is condensed and flows down the tail-pipe.

Condensers of this type require a considerable quantity of water and permit of great waste when no controlling device is employed. Even where salt water is used, this waste should not be permitted because it increases materially the quantity of steam necessary for the operation of the pumps. In many cases where salt water is now used on account of the great quantity required, the use of a well-constructed counter-current condenser operated economically with a precise temperature controller may make possible the use of sweet

water. This is a decided advantage where the condensed water can be used for boiler-feed purposes. I would not recommend its use in the same condition as when it flows from the tail-pipe, in spite of the assertion that condensed water does not contain any impurities carried over from the source of the vapour. In steam engine plants for instance, it is well-known that condensed steam contains oil, &c., and it is never pumped direct to the boilers. It has been determined from frequent analysis that condensed water from vacuum plants does not contain sugar or acid from the evaporation of acid liquor, but the so-called untraceable losses in vacuum plants must necessarily be looked for in

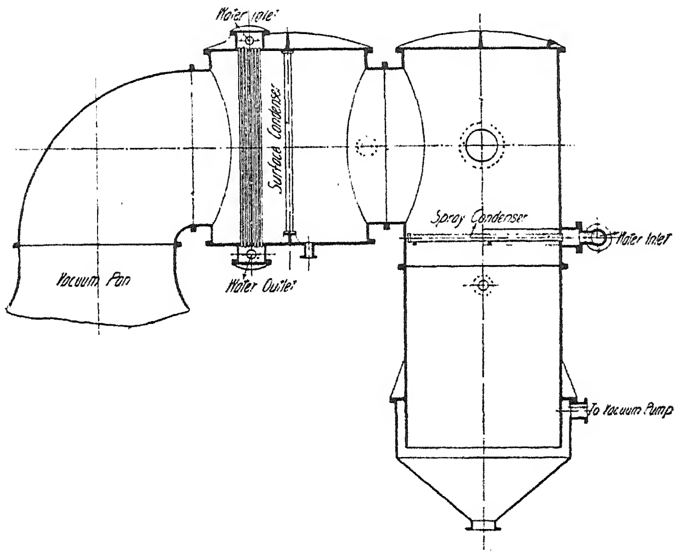


FIG. 5.—COMBINED SURFACE AND SPRAY CONDENSER AS APPLIED TO A VACUUM PAN.

the condensed water. The quantity of water used is so great that the presence of these impurities is not noticeable, but practical experience has proved them to be present. However, when this condensed water at a high temperature (100 to 120°) is passed through an efficient water-purifying plant, there is no doubt that it may safely be used for boiler-feed.

Between January 7th and 15th April, 1911, the duties on sugar imported into Argentina are reduced as follows:—Refined sugar of 96° or more from 9 to 7 cents per kg.; unrefined sugar less than 96° from 6 to $4\frac{1}{2}$ cents per kg.

THE DETERMINATION OF THE SUGAR LOST BY ENTRAINMENT FROM EVAPORATORS.

By R. S. Norris,
Assistant Chemist, Hawaiian Sugar Experiment Station.

In a multiple effect evaporator the entrainment is most pronounced from the last body, on account of the greater volume of the vapour and the greater viscosity of the juice. And as whatever juice is carried out with the vapour from this effect finds its way into the condenser water, it becomes necessary to determine the sugar in a very dilute solution and to know the weight of the solution, that is, of the condenser water. Various devices have also been used for collecting a sample of the vapour leaving the last effect, representing an aliquotic portion of it, and determining the sugar in this; but these are of doubtful value.

As no detailed description of a method for determining the sugar in the condenser water is known to the writer, he has thought it advisable to publish a description of a method used by him in testing a number of evaporators.

The apparatus necessary for the determination is a stove or heater of some kind that can evaporate a considerable volume of water in a short time, a large vessel for evaporating the water in a small evaporating dish holding about 200 c.c., a piece of sheet asbestos about 8 inches (20 cm.) square, a measuring cylinder or flask holding 500 or 1000 c.c., a centigrade thermometer, and the usual sugar laboratory outfit for polarizations.

Five liters of condenser water are collected, a liter at a time, at intervals of half an hour, as it leaves the condenser and as near to it as possible, and placed in a perfectly clean vessel—perferably one that has not had anything containing sugar in it before. The evaporation had best be begun as soon as the first sample is collected, a few drops of sodium carbonate solution being first added. When the water has been evaporated down to about 150 c.c. it is transferred to the small evaporating dish, the last traces being washed out of the large dish into the smaller one. The small dish is placed on the stove over the sheet of asbestos with a two and a half-inch (6 cm.) hole in it. The evaporation is continued until only about 75 c.c. remain—it is not safe to go beyond this on account of the risk of decomposing some of the sugar. The solution is then transferred to a 100 c.c. sugar flask, about 1 c.c. of lead subacetate solution and a little alumina cream added, made up to 110 c.c. filtered and polarized. The polarization of the solution can be found from Schmitz' table, taking the first reading on the left in the table. To find the polarization of the condenser water from this, divide by fifty, since the water was evaporated to one-fiftieth of its original volume.

Weight of Condenser Water corresponding to a Unit Weight of Water Evaporated from Juice.

(For Single Effects, *i.e.*, Vacuum Pans.)

Temp. of water going into condenser in °C.	Temperature of Water coming out of Condensers in °C. 30.	32.	34.	36.	38.	40.	42.	44.	46.	48.	50.	52.	54.	56.	58.	60.
5	24·7	22·8	21·3	19·9	18·7	17·6	16·7	15·8	15·0	14·3	13·7	13·1	12·6	12·1	11·6	11·2
6	25·6	23·7	22·0	20·0	19·2	18·1	17·1	16·2	15·4	14·7	14·0	13·4	12·8	12·3	11·8	11·4
7	26·7	24·6	22·8	21·2	19·8	18·6	17·6	16·6	15·8	15·0	14·3	13·7	13·1	12·5	12·0	11·6
8	27·9	25·6	23·6	21·9	20·4	19·2	18·0	17·0	16·1	15·3	14·6	13·9	13·3	12·8	12·3	11·8
9	29·2	26·8	24·5	22·7	21·1	19·8	18·6	17·5	16·6	15·7	14·9	14·2	13·6	13·0	12·5	12·0
10	30·6	27·8	25·5	23·5	21·8	20·4	19·1	18·0	17·0	16·1	15·3	14·6	13·9	13·3	12·7	12·2
11	32·1	29·1	26·5	24·4	22·6	21·0	19·7	18·5	17·4	16·5	15·7	14·9	14·2	13·6	13·0	12·5
12	33·9	30·5	27·7	25·4	23·4	21·8	20·3	19·0	17·9	16·9	16·0	15·2	14·5	13·9	13·3	12·7
13	35·8	32·0	29·0	26·5	24·3	22·5	21·0	19·6	18·4	17·4	16·4	15·6	14·8	14·2	13·5	12·9
14	38·0	33·7	30·4	27·6	25·3	23·4	21·7	20·2	19·0	17·9	16·9	16·0	15·2	14·5	13·8	13·2
15	40·4	35·7	31·9	28·9	26·4	24·2	22·5	20·9	19·6	18·4	17·3	16·4	15·6	14·8	14·1	13·5
16	43·2	37·8	33·6	30·3	27·5	25·2	23·3	21·6	20·2	18·9	17·8	16·8	15·9	15·1	14·4	13·8
17	46·5	40·3	35·6	31·8	28·8	26·3	24·2	22·4	20·8	19·5	18·3	17·3	16·3	15·5	14·7	14·1
18	50·3	43·1	37·8	33·5	30·2	27·4	25·1	23·2	21·6	20·1	18·9	17·7	16·8	15·9	15·1	14·4
19	54·8	46·3	40·2	35·4	31·7	28·7	26·2	24·1	22·3	20·8	19·4	18·3	17·2	16·3	15·4	14·7
20	60·1	50·1	43·0	37·6	33·4	30·1	27·3	25·1	23·1	21·5	20·0	18·8	17·7	16·7	15·8	15·0
21	66·7	54·6	46·2	40·0	35·3	31·6	28·6	26·1	24·0	22·2	20·7	19·3	18·2	17·2	16·2	15·4
22	74·9	59·9	49·9	42·8	37·5	33·3	30·0	27·2	25·0	23·1	21·4	20·0	18·7	17·6	16·7	15·8
23	85·5	66·5	54·4	46·0	39·9	35·2	31·5	28·5	26·0	23·9	22·2	20·6	19·3	18·1	17·1	16·2
24	99·6	74·7	59·7	49·8	42·7	37·3	33·2	29·9	27·2	24·9	23 0	21·3	19·9	18·7	17·6	16·6
25	119·3	85·2	66·3	53·2	45·9	39·8	35·1	31·4	28·4	25·9	23·9	22·1	20·6	19·2	18·1	17·0
26	148·8	98·2	74·4	59·5	49·6	42·5	37·2	33·1	29·8	27·1	24·8	22·9	21·3	19·8	18·6	17·5
27	198·1	118·9	84·9	65·8	54·0	45·7	39·6	35·0	31·3	28·3	25·8	23·8	22·0	20·5	19·2	18·0
28	..	148·3	98·9	74·2	59·3	49·4	42·4	37·1	33·0	29·7	27·0	24·7	22·8	21·2	19·8	18·5
29	..	197·4	118·5	84·6	65·6	53·9	45·6	39·5	34·8	31·2	28·2	25·8	23·7	21·9	20·4	19·1
30	..	..	147·8	98·6	73·9	59·1	49·3	42·2	37·0	32·9	29·6	26·9	24·6	22·7	21·1	19·7

Weight of Condenser Water Corresponding to a Unit Weight of Water Evaporated from Juice.

(For Triple Effect.)

Temp. of water going into condenser in ° C.	Temperature of water coming out of condenser in ° C. 30.	32.	34.	36.	38.	40.	42.	44.	46.	48.	50.	52.	54.	56.	58.	60.
5	9·1	8·4	7·9	7·4	6·5	6·5	6·2	5·8	5·6	5·3	4·9	4·9	4·7	4·5	4·3	4·2
6	9·5	8·7	8·1	7·6	7·1	6·7	6·3	6·0	5·7	5·4	5·2	5·0	4·7	4·6	4·4	4·2
7	9·9	9·1	8·4	7·8	7·3	6·9	6·5	6·1	5·8	5·5	5·3	5·1	4·8	4·6	4·5	4·3
8	10·3	9·5	8·7	8·1	7·6	7·1	6·7	6·3	6·0	5·7	5·4	5·2	4·9	4·7	4·5	4·4
9	10·8	9·9	9·1	8·4	7·8	7·3	6·9	6·5	6·1	5·8	5·5	5·3	5·0	4·8	4·6	4·4
10	11·3	10·3	9·4	8·7	8·1	7·5	7·1	6·7	6·3	6·0	5·7	5·4	5·1	4·9	4·7	4·5
11	11·9	10·8	9·8	9·0	8·4	7·8	7·3	6·8	6·5	6·1	5·8	5·5	5·3	5·0	4·8	4·6
12	12·5	11·3	10·2	9·4	8·7	8·1	7·5	7·0	6·6	6·3	5·9	5·6	5·4	5·1	4·9	4·7
13	13·2	11·8	10·7	9·8	9·0	8·3	7·8	7·3	6·8	6·4	6·1	5·8	5·5	5·2	5·0	4·8
14	14·0	12·5	11·2	10·2	9·4	6·6	8·0	7·5	7·0	6·6	6·2	5·9	5·6	5·4	5·1	4·9
15	15·0	13·2	11·8	10·7	9·8	9·0	8·3	7·7	7·2	6·8	6·4	6·1	5·8	5·5	5·2	5·0
16	16·0	14·0	12·4	11·2	10·2	9·3	8·6	8·0	7·5	7·0	6·6	6·2	5·9	5·6	5·3	5·1
17	17·2	14·9	13·2	11·8	10·6	9·7	8·9	8·3	7·7	7·2	6·8	6·4	6·0	5·7	5·5	5·2
18	18·6	15·9	14·0	12·4	11·2	10·1	9·3	8·6	8·0	7·4	7·0	6·6	6·2	5·9	5·6	5·3
19	20·3	17·1	14·9	13·1	11·7	10·6	9·7	8·9	8·3	7·7	7·2	6·8	6·4	6·0	5·7	5·4
20	22·2	18·5	15·9	13·9	12·4	11·1	10·1	9·3	8·6	8·0	7·4	7·0	6·5	6·2	5·9	5·6
21	24·7	20·2	17·1	14·8	13·1	11·7	10·6	9·7	8·9	8·2	7·7	7·2	6·7	6·4	6·0	5·7
22	27·7	22·2	18·5	15·8	13·9	12·3	11·1	10·1	9·2	8·5	7·9	7·4	6·9	6·5	6·2	5·8
23	31·6	24·6	20·1	17·0	14·8	13·0	11·7	10·5	9·6	8·9	8·2	7·6	7·2	6·7	6·3	6·0
24	36·8	27·6	22·1	18·4	15·8	13·8	12·3	11·1	10·1	9·2	8·5	7·9	7·4	6·9	6·5	6·1
25	44·1	31·5	24·5	20·1	17·0	14·7	13·0	11·6	10·5	9·6	8·8	8·2	7·6	7·1	6·7	6·3
26	55·1	36·7	27·5	22·0	18·4	15·7	13·8	12·2	11·0	10·0	9·2	8·5	7·9	7·4	6·9	6·5
27	73·3	44·0	31·4	24·4	20·0	16·9	14·7	12·9	11·6	10·5	9·6	8·8	8·2	7·6	7·1	6·6
28	..	54·9	36·6	27·4	22·0	18·3	15·7	13·7	12·2	11·0	10·0	9·2	8·6	7·9	7·3	6·9
29	..	..	43·8	31·3	24·3	19·9	16·9	14·6	12·9	11·5	10·4	9·5	8·8	8·1	7·6	7·1
30	..	..	54·7	36·5	27·4	21·9	18·2	15·6	13·7	12·2	11·0	10·0	9·1	8·4	7·8	7·3

Weight of Condenser Water corresponding to a Unit Weight of Water Evaporated from Juice.

(For Quadruple Effects.)

Temp. of water going into Condenser in °C.	Temperature of Water coming out of Condenser in °C.															
	30.	32.	34.	36.	38.	40.	42.	44.	46.	48.	50.	52.	54.	56.	58.	60.
5	7·0	6·5	6·0	5·6	5·3	5·0	4·7	4·5	4·3	4·1	3·9	3·7	3·6	3·4	3·3	3·2
6	7·3	6·7	6·2	5·8	5·5	5·1	4·9	4·6	4·4	4·2	4·0	3·8	3·6	3·5	3·4	3·2
7	7·6	7·0	6·5	6·0	5·6	5·3	5·0	4·7	4·5	4·3	4·1	3·9	3·7	3·6	3·4	3·3
8	7·9	7·3	6·7	6·2	5·8	5·4	5·1	4·8	4·6	4·4	4·1	4·0	3·8	3·6	3·5	3·3
9	8·3	7·6	7·0	6·4	6·0	5·6	5·3	5·0	4·7	4·5	4·2	4·0	3·9	3·7	3·6	3·4
10	8·7	7·9	7·2	6·7	6·2	5·8	5·4	5·1	4·8	4·6	4·3	4·1	3·9	3·8	3·6	3·5
11	9·1	8·3	7·5	6·9	6·4	6·0	5·6	5·3	5·0	4·7	4·4	4·2	4·0	3·9	3·7	3·5
12	9·3	8·7	7·9	7·2	6·7	6·2	5·8	5·4	5·1	4·8	4·6	4·3	4·1	3·9	3·8	3·6
13	10·2	9·1	8·2	7·5	6·9	6·4	6·0	5·6	5·2	4·9	4·7	4·4	4·2	4·0	3·8	3·7
14	10·8	9·6	8·6	7·8	7·2	6·6	6·2	5·7	5·4	5·1	4·8	4·5	4·3	4·1	3·9	3·7
15	11·5	10·1	9·1	8·2	7·5	6·9	6·4	5·9	5·6	5·2	4·9	4·7	4·4	4·2	4·0	3·8
16	12·3	10·7	9·6	8·6	7·8	7·2	6·6	6·1	5·7	5·4	5·1	4·8	4·5	4·3	4·1	3·9
17	13·2	11·4	10·1	9·0	8·2	7·5	6·9	6·4	5·9	5·5	5·2	4·9	4·6	4·4	4·2	4·0
18	14·3	12·2	10·7	9·5	8·6	7·8	7·1	6·6	6·1	5·7	5·4	5·0	4·8	4·5	4·3	4·1
19	15·6	13·2	11·4	10·1	9·0	8·1	7·4	6·8	6·3	5·9	5·5	5·2	4·9	4·6	4·4	4·2
20	17·1	14·2	12·2	10·7	9·5	8·5	7·8	7·1	6·6	6·1	5·7	5·3	5·0	4·7	4·5	4·3
21	18·9	15·5	13·1	11·4	10·0	9·0	8·1	7·4	6·8	6·3	5·9	5·5	5·2	4·9	4·6	4·4
22	21·3	17·0	14·2	12·2	10·6	9·5	8·5	7·7	7·1	6·5	6·1	5·7	5·3	5·0	4·7	4·5
23	24·3	18·9	15·4	13·1	11·3	10·0	8·9	8·1	7·4	6·8	6·3	5·9	5·5	5·1	4·9	4·6
24	28·3	21·2	17·0	14·1	12·1	10·6	9·4	8·5	7·7	7·1	6·5	6·1	5·7	5·3	5·0	4·7
25	33·9	24·2	18·8	15·4	13·0	11·3	10·0	8·9	8·1	7·4	6·8	6·3	5·8	5·5	5·1	4·8
26	42·3	28·2	21·1	16·9	14·1	12·1	10·6	9·4	8·5	7·7	7·0	6·5	6·0	5·6	5·3	5·0
27	56·3	33·8	24·1	18·7	15·3	13·0	11·3	9·9	8·9	8·0	7·3	6·8	6·3	5·8	5·4	5·1
28	..	42·2	28·1	21·1	16·9	14·0	12·0	10·5	9·4	8·4	7·7	7·0	6·5	6·0	5·6	5·3
29	..	..	33·6	24·0	18·6	15·3	12·9	11·2	9·9	8·9	8·0	7·3	6·7	6·2	5·8	5·4
30	..	..	42·0	28·0	21·0	16·8	14·0	12·0	10·5	9·3	8·4	7·6	7·0	6·5	6·0	5·6

For instance, suppose the polariscope reading were 3·0, the 100 c.c. of evaporated solution would then have a polarization of 0·85 and the original condenser water a polarization of 0·017.

In order to interpret this in pounds of sugar lost in condenser water per day, it is only necessary to know the weight of condenser water. This can be calculated from the volume measured with a weir, or it can be found in terms of the weight of juice by taking the temperature of the water going in and coming out of the condenser with a centigrade thermometer, and referring to the accompanying tables, which give the weight of condenser water corresponding to unit weight of water evaporated from the juice. And this number multiplied by the percentage evaporation, calculated from the formula:

Per cent. evaporation (by weight) =

$$\frac{\text{Brix of Evaporated Juice—Brix of Thin-Juice,}}{\text{Brix of Evaporated Juice}}$$

gives the weight of condenser water corresponding to unit weight of juice entering evaporator.* This result, multiplied by the weight of mixed juice or diffusion juice for twenty-four hours, gives the weight of condenser water per day, from which the weight of sugar in the condenser water for one day can be calculated directly, by multiplying by its polarization as found above. For example, with a triple effect, suppose we have:

Temperature of water going into condenser	20°C.
Temperature of water coming out of condenser ..	42°C.
Brix of clarified or thin-juice	14·7
Brix of syrup or thick-juice	62·0
Weight of mixed juice or diffusion juice in one day.	500 tons.

Using these figures, we find from the table that there are 10·1 pounds of condenser water for each pound of water evaporated from the juice. The evaporation calculated from the formula is 76·3 per cent. We therefore have 10·1 × 0·763 = 7·7 pounds of condenser for each pound of juice. And since the diffusion, or mixed juice weighs 1,000,000 pounds, the condenser water will weigh 1,000,000 × 7·7 = 7,700,000 pounds and contain 7,700,000 × 0·00017 = 1309 pounds of sugar per day.

The tables were calculated from the formulae†

$$\text{(I) } W a = \frac{w\,(c - t_b)}{t_b - t_a}, \quad \text{(II) } W b = (W a + \mathrm{I})E,$$

in which

W_a = weight of injection water going into condenser;

W_b = weight of water coming out of condenser;

w = weight of vapour from last body;

---

* For convenience this may be taken to be equal to the weight of diffusion juice or mixed juice, which is usually known.

† For a discussion of formula I. see E. Hausbrand, "Evaporating, Condensing and Cooling Apparatus," p. 212.

c = total heat of unit weight of vapour from last body, in calories;
t_a = temperature in °C. of injection water going into condenser;
t_b = temperature in °C. of water coming out of condenser;
E = average per cent. evaporation in last body.

In calculating the tables the factor c is taken equal to 621·3, which is the total heat of unit weight of steam under a vacuum of 25 in. The corresponding factors at other pressures are:—

Inches.	Calories.	Inches.	Calories.
22	625·9	26	619·5
23	624·4	27	616·8
24	623·1	28	613·4

For the factor E the following numbers were used in the calculations:—

Single Effect	1·000
Double Effect	0·534
Triple Effect	0·370
Quadruple Effect	0·284
Quintuple Effect	0·235

—(*Jl. Ind. Eng. Chem.*)

SCOTTISH MACHINERY FOR SUGAR ESTATES.

Under this heading there appeared in a recent issue of the *Engineering Supplement* of *The Times* some interesting details of the work done at Glasgow, in 1910, by way of fulfilling orders for sugar machinery in various parts of the world. These show that British engineers are more than holding their own, and it is particularly gratifying to note that in Cuba and even in Porto Rico they are getting their share of custom. Indeed as regards Cuba, it is predicted there will be even more valuable shipments of machinery there from the Clyde within the next year or two. There is of course the American preferential tariff of $2\frac{1}{2}$ per cent. *ad valorem* to overcome, but as Cuban planters are tending to look on British machinery as the cheapest and best, the latter is coming in freely.

Formosan orders continue to be secured in this country, though the competition of Americans doubtless makes the bidding very keen in this quarter. Other places that have purchased Scotch machinery are Mauritius, Portuguese East Africa, South Africa, Mexico, Argentina, and Australia. West Indian orders were also plentiful and even in Barbados there has been ample scope for the placing of new and up-to-date machinery.

The Mirrlees Watson Company, Ltd., we learn, despatched amongst other orders a 14-roller mill of very large capacity to Mauritius, and a complete factory to Portugese East Africa. They also supplied the

plant for two Formosan factories to deal each with 750 tons a day; and increased the capacity of the Antigua Central Factory by 50 per cent. by means of additional machinery. They moreover sent at least one sugar plant to Porto Rico.

Messrs. Duncan Stewart & Co., Ltd., have shipped complete plants or special lots of machinery to a large number of sugar estates in Barbados; they have also dispatched plant to Cuba, Jamaica, Demerara, and Mexico. The Cuban factory they are interested in, the Stewart Central, has done very well and has recently been fitted with additional boilers and machinery.

The above two firms are the only ones whose output is described at any length by *The Times* article. We may, however, fitly add some particulars of at least one other representative firm which has also done well.

The Harvey Engineering Company, Ltd., Glasgow, who end their year with June and not December, last year beat their previous record in output by fully 25 per cent. The present year they are expecting to do better still. They have supplied machinery to all the principal cane sugar districts; in particular to Cuba, which has been of late a very large customer of theirs. This firm, it may be added, have the unique distinction of being the only one in Great Britain who practically confine themselves to the production of sugar plant and devote their energies solely to this branch of machinery. Their success or failure is therefore probably a truer indication of the state of the sugar machinery trade for the time being than is that of firms who have several other "strings to their bow."

DETERMINATION OF WATER IN RAW SUGARS BY MEANS OF THE IMMERSION REFRACTOMETER.

By V. Stanek,

Assistant Chemist at the Prague Experimental Station.

Although the Pulfrich immersion refractometer* is one of the most precise analytical instruments, allowing of the determination of various substances in solution within a limit of error of ± ·017 per cent., its use has hitherto been limited to saturated juices and sweet-waters, since its scale allows of direct readings only as far as a concentration of 23·49 grms. of sugar in 100 c.c., or 21·71 per cent. by weight.

The numerous advantages which the immersion refractometer possesses over the Abbe instrument, such as direct readings in ocular degrees, sharp distinction between light and shadow, and lower price, have induced me to experiment upon the extension of its application

* Made by the well-known firm of Zeiss.

to other factory products. In this article the determination of water in raw sugar is discussed.

The principle involved in this determination is the same as in estimating sugar by the polarimeter. The sugar is weighed out, washed into a flask, dissolved, made up to 100 c.c., and the grms. of dry substance per 100 c.c. ascertained by the refractometer, this reading being finally calculated on 100 parts of the sugar examined. The concentration of the solution cannot be read directly from the scale on the Pulfrich instrument, as in the case of the polarimeter, but must be calculated by means of a table. Two such tables are in use: that of Wagner (given on page 46 of his "Tabellen zum Eintauchrefraktometer"), and that of Wagner (see the *D. Zuckerind.*, 1908, *33*, 106-108), the first giving the grms. of sugar per 100 c.c., and the latter the percentage by weight.

The author has constructed a new table for 20 grms. of sugar in 100 c c., which gives directly at 17·5° C. the equivalents of refractometric readings and percentages of water in the raw sugar examined:

TABLE 1.

WATER CONTENT OF RAW SUGAR.

20 grms. in 100 c.c. at 17·5° C.

Refractometer Degrees.	Percentage of Water.	Refractometer Degrees.	Percentage of Water.	Refractometer Degrees.	Percentage of Water.	Refractometer Degrees.	Percentage of Water.
88·0	4·900	89·0	3·650	90·0	2·400	91·0	1·150
88·1	4·775	89·1	3·525	90·1	2·275	91·1	1·025
88·2	4·650	89·2	3·400	90·2	2·150	91·2	0·900
88·3	4·525	89·3	3·275	90·3	2·025	91·3	0·775
88·4	4·400	89·4	3·150	90·4	1·900	91·4	0·650
88·5	4·275	89·5	3·025	90·5	1·775	91·5	0·525
88·6	4·150	89·6	2·900	90·6	1·650	91·6	0·400
88·7	4·025	89·7	2·775	90·7	1·525	91·7	0·275
88·8	3·900	89·8	2·650	90·8	1·400	91·8	0·150
88·9	3·775	89·9	2·525	90·9	1·275	91·9	0·025

Correction for hundredths of a scale-division:

0·03 scale division = — 0·04 per cent. Water.
0·05 ,, ,, = — 0·06 ,, ,,
0·07 ,, ,, = — 0·09 ,, ,,

Since maintaining a temperature of 17·5° C. within a tenth of a degree is very troublesome, it was necessary to draw up yet another correction table, permitting one to work at the prevailing temperature:

TABLE 2.

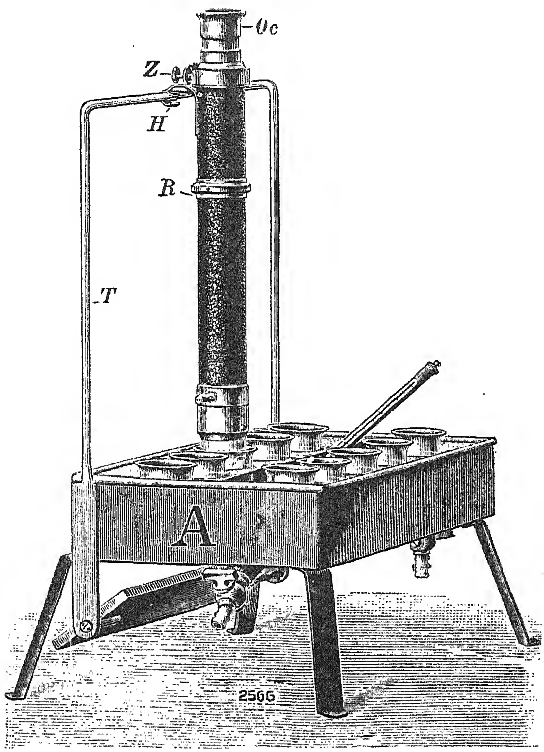
TEMPERATURE CORRECTION TABLE FOR THE REFRACTOMETRIC DETERMINATION OF WATER IN RAW SUGAR.

Degrees Centigrade.	To be Subtracted.	Degrees Centigrade.	To be Added.	Degrees Centigrade.	To be Added.	Degrees Centigrade.	To be Added.
15·0	0·72	17·6	0·03	20·2	0·82	22·8	1·62
15·1	0·70	17·7	0·06	20·3	0·85	22·9	1·65
15·2	0·67	17·8	0·09	20·4	0·88	23·0	1·69
15·3	0·64	17·9	0·12	20·5	0·91	23·1	1·72
15·4	0·61	18·0	0·15	20·6	0·94	23·2	1·75
15·5	0·58	18·1	0·18	20·7	0·97	23·3	1·78
15·6	0·55	18·2	0·21	20·8	1·00	23·4	1·81
15·7	0·52	18·3	0·24	20·9	1·03	23·5	1·85
15·8	0·49	18·4	0·27	21·0	1·06	23·6	1·88
15·9	0·46	18·5	0·30	21·1	1·09	23·7	1·91
16·0	0·44	18·6	0·33	21·2	1·12	23·8	1·96
16·1	0·41	18·7	0·36	21·3	1·15	23·9	1·99
16·2	0·38	18·8	0·39	21·4	1·18	24·0	2·03
16·3	0·35	18·9	0·42	21·5	1·22	24·1	2·06
16·4	0·32	19·0	0·45	21·6	1·25	24·2	2·09
16·5	0·29	19·1	0·48	21·7	1·28	24·3	2·12
16·6	0·26	19·2	0·51	21·8	1·31	24·4	2·15
16·7	0·23	19·3	0·54	21·9	1·34	24·5	2·19
16·8	0·20	19·4	0·57	22·0	1·37	24·6	2·22
16·9	0·17	19·5	0·61	22·1	1·41	24·7	2·25
17·0	0·15	19·6	0·64	22·2	1·44	24·8	2·29
17·1	0·12	19·7	0·67	22·3	1·47	24·9	2·32
17·2	0·09	19·8	0·70	22·4	1·50	25·0	2·35
17·3	0·06	19·9	0·73	22·5	1·53	25·1	2·38
17·4	0·03	20·0	0·76	22·6	1·56	25·2	2·42
17·5	0·00	20·1	0·79	22·7	1·59	25·3	2·45

In determining the water in raw sugar, the following procedure was followed:—20 grms. of raw sugar were weighed out, washed into a 100 c.c. flask, dissolved, made up almost to the mark with water at the temperature of the room, and mixed by spinning between the palms of the hands. The flask was then immersed in water at room temperature for 20 to 30 minutes, made up exactly to the mark with water at room temperature, and shaken. A portion of the sugar solution was then poured into the refractometer beaker, or, better,

into a prism cell,* which latter obviates evaporation, and read after two minutes.

So as to check the accuracy of the refractometer, 20·02 grms. of pure sugar (dried refined) may be dissolved in water in a standardized flask, and after adjusting made up to 100 c.c. at 17·5° C., and read in the refractometer. If the reading is not exactly 92·0, a correction must be made for the observed difference in the subsequent determinations. The temperature readings must be made only with a reliable thermometer, divided into tenths, such as the firm of Zeiss supply.



The refractometric determination is more convenient than the polarimetric sugar determination, since clarification and filtration are obviated, although, on account of adjusting the temperature, the time required is longer. If the necessary precautions are observed, the

---

* The author has constructed a vessel, through which the liquid may flow, on the principle of the Pellet tube. This allows of very quick work, and will be reported upon later.

maximum error between two separate determinations is 0·06 per cent. Readings are easily made, and the border-line is always very sharp, even with dark solutions.

TABLE 3.

SOME RESULTS OBTAINED.

Water per cent., by desiccation at 105° C.	Refractometric readings.	Temperature ° C.	Correction reading.	Corrected result.	Percentage of water refractometrically.	Difference between the two methods.	Difference between the two refractometric determinations.
	89·95	17·4	— 0·03	89·98	2·54	+ 0·08	
2·46	88·90	20·9	+ 1·03	89·93	2·56	+ 0·10	0·02
	89·60	16·2	— 0·38	89·22	3·38	+ 0·12	
3·26	87·90	22·0	+ 1·37	89·27	3·31	+ 0·05	0·07
	89·70	17·1	— 0·12	89·58	2·92	— 0·06	
2·98	87·70	23·6	+ 1·88	89·58	2·92	— 0·06	0
	89·60	17·1	— 0·12	89·48	3·05	+ 0·06	
2·99	87·95	22·5	+ 1·53	89·48	3·05	+ 0 06	0
	90·30	17·5	± 0	90·30	2·03	+ 0·02	
2·01	89·40	20·4	+ 0·88	90·28	2·05	+ 0·04	0·02
	90·60	15·0	— 0·72	89·88	2·54	+ 0·08	
2·46	88·65	21·6	+ 1·25	89·90	2·52	+ 0·06	0·02
	89·95	17·5	± 0	89·95	2·46	— 0·08	
2·54	89·00	20·4	+ 0·88	89·88	2·54	± 0	0·08
	90·45	16·2	— 0·38	90·07	2·30	— 0·05	
2·35	88·70	21·8	+ 1·31	90·01	2·39	+ 0·04	0·09
	89·65	17·5	± 0	89·65	2·84	+ 0·14	
2·70	88·75	20·4	+ 0·88	89·63	2·86	+ 0·16	0·02
	91·20	15·1	— 0·70	90·50	1·77	+ 0·02	
1·75	91·15	15·3	— 0·64	90·51	1·76	+ 0·01	0·01

In Table 3 the results of a series of water estimations in sugars of different source are summarized. The determinations were carried out, on the one hand by the commercial method of drying 10 grms. of the sugar at 105° C. in a glycerin oven, and on the other hand refractometrically, using two different temperatures. From these figures it is apparent that the results agree fairly well within the

limit of error of the refractometric method, viz., 0·06 per cent. Here and there greater errors are observable, but these are due to the same sources of error attendant on the polarimetric method, viz., non-homogeneous sampling, air bubbles, and the like. As was to be expected, errors due to the greater refractive index of the non-sugars were not observable, the differences from the desiccation method being sometimes positive and sometimes negative.

At present the author is engaged in working out a standard method of dry substance determination with the immersion refractometer on the above principle for other sugar factory products.—(Abridged from *Zeitsch. Zuckerind. Böhm.*).

HEAT AND VAPOUR LOSSES IN EVAPORATORS.

By V. Jakš.

At the present time a great deal is not known of the actual extent of the heat losses of evaporators by radiation.

Dr. Claassen recently gave (*vide* this *Jl.*, 1910, 309) the loss of heat caused by radiation in a quadruple with juice-heater, the total heating surface being 1450 square metres, and the capacity 1000 metric tons of roots. In this calculation, the surfaces in contact with either vapour or juice of like temperature were taken together, whereas in the following calculation the walls of the vapour and juices spaces are treated separately for each separate body.

The total length of piping connecting any two bodies Claassen gives as 8 metres, whilst in my calculation the exact length and diameter of the single connections, both for vapour and for juice, are considered.

The heat loss by radiation depends principally upon the difference of temperature between the walls radiating heat, and the surrounding atmosphere, and also upon the conductivity of the walls.

For calculating the heat loss of naked walls, the author uses Péclet's table, as also Claassen did. Whilst, however, this investigator assumed that by lagging the total loss of heat is diminished by 50 per cent., the present author calculated this loss for each single body as 20 to 60 per cent. of the loss established by Péclet, according to the quality and thickness of the lagging of the several bodies.

LOSS OF HEAT BY RADIATION PER HOUR.

	Area of walls in sq. metres.	Difference of Temperature ° C.	Calories per sq. metre of naked wall (by Péclet).	Calories for the total area of naked wall.	For all the isolated surface, per cent.	For the whole body in calories.	Vapour in kilos.
CIRCULATORS.							
Steam space	16·89	133	1170	19,761·3	60	86,264·6	161·70
Juice ,, ...	18·31	89	680	23,405·6			
Juice piping	16·11						
FIRST BODY.							
Evaporating chamber ..	12·40	94	732	9,076·8	40		
Other space	141·84	89	680	141,834·4			
Vapour piping	56·84						
Juice ,, ...	9·90						
SECOND BODY.							
Evaporating chamber ..	5·56	89	680	10,995·6	30	30,174·5	56·22
Steam space	10·61						
Other ,, ...	49·66	84	632	89,586·0			
Juice ,, ...	52·18						
Vapour piping	33·14						
Juice ,, ...	6·77						
THIRD BODY.							
Steam space	9·38	84	632	5,928·1	20	8,104·1	14·96
Juice ,, ...	40·89	75	547	34,592·3			
Vapour piping	19·93						
Juice ,, ...	2·42						
FOURTH BODY.							
Steam space	9·79	75	547	5,355·1	20	9,637·4	17·61
Juice ,, ...	47·53	66	464	42,831·9			
Vapour piping	26·97						
Juice ,, ...	17·81						
FIFTH BODY.							
Steam space	26·05	66	464	12,087·2	30	10,529·1	18·71
Juice ,, ...	94·69	39	243	23,009·7			

Thus, while the 1st body evaporates 30·5 per cent., the 2nd 17·7 per cent., the 3rd 16·5 per cent., the 4th 17·2 per cent. and the 5th 18·1 per cent. of water, and the loss of vapour by radiation amounts to 100 per cent. of the computed loss only in the 1st body, this loss is, in the 2nd body, 100 — 30·5 = 69·5 per cent.; in the 3rd, 69·5 — 17·7 = 51·80 per cent.; in the 4th, 51·8 — 16·5 = 35·3 per cent.; and in the 5th, 35·3 — 17·2 = 18·1 per cent. Altogether there is lost 161·7 + 0·695 × 56·22 + 0·518 × 14·96 + 0·353 × 17·61 + 0·181 × 18·71 = 218·14 kilos. per hour, and 5,235·36 kilos. in 24 hours, *i.e.*, on 100 kilos. of roots for a daily working of 7063·6 quintals: 5235/7063·6 = 0·74 kilo. of steam.

According to Dr. Claassen, this loss in the case of the quadruple apparatus with juice-heater attached cited by him is 149·4 kilos. per hour, or 3600 kilos. in 24 hours, working 5000 quintals of roots.—(Abridged from *Zeitsch. Zuckerind. Böhm.*)

THREE FORMULAE FOR SUGAR CANE FERTILIZERS.

The last annual Report of the Queensland Sugar Experiment Stations mentioned that there were three manurial mixtures which had been found to give good payable results wherever tried.

The first consisted of

250 lbs. sulphate of ammonia, containing about 50 lbs. nitrogen.
100 lbs. sulphate of potash, containing about 50 lbs. potash.
and 300 lbs. superphosphate, containing about 45 lbs. water-soluble phosphoric acid.

650 lbs. to be applied per acre.

On a percentage composition, this mixture would contain approximately: Nitrogen, 7·7 per cent.; potash, 7·7 per cent.; water-soluble phosphoric acid, 7·0 per cent. It would be more useful still if half the nitrogen were applied with the rest of the manure as a first dressing, and the remainder added two to three months later as a top second dressing.

No. 2 mixture was: Sulphate of ammonia, 150 lbs.; sulphate of potash, 150 lbs.; meatworks manure, 300 lbs.: the 600 lbs. to be applied per acre. The sulphate of ammonia should be divided, the first half being applied with a drill with the sulphate of potash and meatworks manure, the rest being applied on the surface around the cane two months later.

The following mixture, which contains more nitrogen and potash per acre, can be advantageously given in some cases:—

200 lbs. nitrate of soda, containing about 30 lbs. of nitrogen.
200 lbs. sulphate of ammonia, containing about 40 lbs. of nitrogen.
150 lbs. sulphate of potash, containing about 75 lbs. of potash.
300 lbs. superphosphate, containing about 50 lbs. of water-soluble phosphoric acid.

850 lbs. per acre.

Here also the nitrogen could be advantageously divided, one-half being applied with the other ingredients and the other half two or three months later. In this second application the scattering of the nitrate of soda and sulphate of ammonia on the surface near the stools will suffice as it rapidly becomes absorbed by the soil.

Mixed fertilizers are best applied to the sugar cane plant crop by applying the same in drills 4 to 5 inches deep on each side of the row, and about 6 inches from the row, when the plants are from 12 to 18 inches high, and then covering the drills in.

For ratoons when the land is being worked between the rows, as it always should be, the manures can be dropped in the furrow ploughed away from the stools, and covered when ploughing back to the row. This should be done immediately after the application, so as to prevent loss. Thorough cultivation is essential in order to obtain the best results from fertilizing, and subsoiling is especially valuable. The growth and ploughing in of a leguminous crop every time after stools are ploughed out should be imperative.

PUBLICATIONS.

Cane Sugar: A Text Book on the Agriculture of the Sugar Cane, the Manufacture of Cane Sugar, and the Analysis of Sugar House Products; together with a Chapter on the Fermentation of Molasses. By Noël Deerr, Sugar Technologist at the Experiment Station of the Hawaiian Sugar Planters' Association; Author of "Sugar and the Sugar Cane." xvi. + 592 pp., Royal 8vo., 280 illustrations. Norman Rodger, Altrincham (Manchester). 1911. 20s. net.

The progress of sugar production within the memory of some still living is a remarkable study. Some of us can recollect what sugar production was in the middle of the nineteenth century, and can compare it with what it is now. There were no sugar chemists in those days, and as to sugar engineers, they were confined to the makers of the newly invented vacuum pan and its primitive appliances, the ordinary equipment of the small sugar refinery of the period, a few early improvements in cane crushing, and the usual plant for "the copper wall" or some early substitute for it. The polariscope had been heard of but had not yet been used, and no one knew much about glucose, dextrose, or levulose. The ash coefficient, the quotient of purity, and other similar ideas were then not even in embryo. Then came the beetroot and all its wonderful works. In 1860 (not 1866) the *Journal des Fabricants de Sucre* made its first appearance in Paris. We began to read abstruse articles by Dubrunfaut and others, and to learn many interesting facts about sugar. Walkhoff's

great book on the production of beetroot sugar did not appear till 1872. That was a revelation to most readers outside the European beetroot district, and very likely to some inside it. There had been one or two works about cane sugar before that date, even as far back as 1843, but there seem to have been only three or four previous to the year 1852. Then came one or two from Mauritius and Guadeloupe. As far as cane sugar was concerned those two places, with Martinique, were the first to show the way in scientific progress. A solitary sugar planter in Madras was a man before his time, who learned his lesson in Germany and Austria. Java was the first by a ong way to turn out really fine raw sugar. There has been no raw sugar like it since, and its high quality is now not quite what it used to be. Cane juice was a purer article when we only got 70 to 80 per cent. of it than it is now that we get 90 to 95.

The great progress began with the appearance of Walkhoff's book in 1872. The *Journal des Fabricants de Sucre* was teeming with interesting discussions of disputed points, and every one who took the trouble was learning valuable lessons day by day. Alfred Fryer started *The Sugar Cane* in 1869, and that journal, with its enlargement in 1899 into *The International Sugar Journal*, has been the English *vade mecum*. Then came the *Sucrerie Indigène et Coloniale*, of which the writer possesses countless bound copies since a very early date, the *Sucrerie Belge* and *Die Deutsche Zuckerindustrie*. People in the sugar industry began to get quite learned, refiners began to start chemical laboratories, and so did the cane sugar producers. The beetroot *fabricant* had done so years before. The men of the United States were not slow to learn their lesson from British refiners and the European beetroot industry, and we now get *The Louisiana Planter*, *The Sugar Journal*, *The American Sugar Industry and Beet Sugar Gazette*, *The Sugar Beet*, *The Australian Sugar Journal*—all devoted to the laudable task of spreading far and wide the latest information about sugar production. English books about sugar were rather scarce in early days. The brothers Newlands, eminent chemists, brought out a massive work many years ago, and thus showed that when England does begin to deal with a new subject it does it thoroughly. It was an exhaustive treatise and has just reappeared in a new edition brought up to date. In America came two books on beet sugar manufacture, by Claassen and Ware, very thorough works. Then came the remarkable and very original works of H. C. Prinsen Geerligs, giving splendid details of his experiences at the West Java Sugar Experiment Station, the first, "On Cane Sugar and the Process of its manufacture in Java," issued from the office of the *Sugar Cane* in 1902, followed in 1909 by a much larger treatise, entitled "Cane Sugar and its Manufacture." This is a thoroughly standard work as far as the chemistry of the subject is concerned. The author refers his reader for technical details as to machinery to Mr. Noël Deerr's book, "Sugar and the

Sugar Cane," also published by Mr. Norman Rodger at Altrincham (Manchester), which appeared in 1905.

But the march of events in the development of the world's sugar industry is so rapid that Mr. Noël Deerr, like his predecessor Mr. Prinsen Geerligs, has been obliged to re-write his former work, and as the result we get the present exhaustive treatise, the title of which stands at the head of this review. In the meantime, another great work had appeared in 1909, "The Manufacture of Cane Sugar," by Llewellyn Jones, M.I.E.S., and Frederic J. Scard, F.I.C., published by Edward Stanford. This is an extremely handsome and most valuable addition to our recent sugar literature. The coloured frontispiece of a "typical stool of D 625 sugar cane, from a painting by Miss Van Nooten," is a work of art of the highest excellence, reminding one of the pencil drawing by the late Lord Leighton of a lemon tree. The lady has been quite as careful with her drawing as the late P.R.A.

Mr. Noël Deerr's new book is a perfect mine of information, full of the most elaborate technical details, not only of the machinery, to his description of which Mr. Prinsen Geerligs referred the readers of his book, but also of all the complicated chemical facts to which experts like Geerligs have been devoting their attention for the last ten years. Mr. Deerr has much original matter to add, on both these branches of the science of sugar production, as the result of his own researches at the Hawaiian Sugar Planters' Experimental Station. His book has consequently grown enormously both in bulk and value. It may be regarded as an exhaustive treatise up to 1911. Like all other books of science it will probably have to be added to from time to time, but in this year, 1911, it is the latest possible utterance on everything connected with the technology of cane sugar.

His opening chapters on the Cane, The Composition of the Cane, Range and Climate, Varieties of the Cane, Sugar Cane Soils, The Manuring of the Cane, The Irrigation of the Cane, The Husbandry of the Cane, and last but not least, The Pests and Diseases of the Cane, are full of new and original matter. Out of his 544 pages they occupy 170. That is to say that he has more than doubled what he had to say on those subjects in his former work of only five years ago.

These chapters the inquiring reader should study with care; they are full of good things. But there are other branches of the science on which Mr. Deerr has much new matter to put before his readers. "The Extraction of Juice by Mills" is a much fuller and newer statement of the subject than it was five years ago; in fact, nearly double the quantity of matter.

In his chapter on the Diffusion Process, though it now has small interest for the cane sugar producer, one would have liked to have seen some mention of the distinguished men to whom we are indebted

for the discovery or indication of the phenomena on which the process is based, and for their practical application in the diffusion battery. It was Thomas Graham, the great English chemist of the middle of last century, who was the first, or among the first, to demonstrate the fact of what he called osmosis, or dialysis, or diffusion, and it was undoubtedly Julius Robert, of Séelowitz in Austria (Moravia), who applied the idea of diffusion and constructed the diffusion battery which is now in universal use for extracting the juice from the sugar beet. To be perfectly correct it ought to be added that Dutrochet, in 1826, was the first to discover that organic membranes had the property of permitting the flow through them of substances in solution, and he called this phenomenon "*Endosmose.*" Graham's observations began in 1849, and he called the action "Diffusion." In 1854 Dubrunfaut took up the subject and, in 1863, constructed the *Osmogène* for the extraction, by diffusion, of the salts contained in large quantities in beetroot molasses. But it appears that it was Graham who, in 1862, established the fact that, from a mixture of crystallizable and uncrystallizable substances in solution, it was the crystallizable substances that passed through the membrane while the uncrystallizable remained in the original solution. He called the two classes of substances *Crystalloids* and *Colloids*, and defined the operation as *Dialysis.* The reason why, in Dubrunfaut's Osmogène, the salts diffuse out while the sugar remains behind, is not because the salts are more diffusible than the sugar but because the sugar has become a colloid, having formed viscous compounds with the impurities of the molasses.

Diffusion has not been altogether a success in cane sugar factories for a variety of reasons, but so long as diffusion was able to extract more juice than was obtained in the mills there was some reason for hoping for its success, especially as diffusion juice is purer than mill juice. Mr. Deerr puts a finishing touch to the many objections to diffusion as applied to cane factories by stating that now "at the present moment (1909) in Hawaii there are quadruple crushing plants at work, obtaining an extraction averaging 95 per cent. without fuel consumption other than that afforded by the megass. The best work claimed for diffusion is an extraction of 96 per cent. to 98 per cent., but in no case is this obtained without a considerable consumption of extra fuel, and with a dilution higher than that found in milling processes."

The chapter on the Carbonation Process* is suggestive, and leads up to a very interesting point which ought to receive much careful attention from both cane and beet sugar producers. Mr. Deerr says that "the double carbonation process is used in a few factories in

---

*Mr. Deerr prefers the word "Carbonation" as being etymologically the correct form. Mr. Geerligs uses the word "Carbonatation" which is the French form of spelling.

Java, and perhaps in one or two elsewhere. By its use a white sugar intended for direct consumption is obtained with less trouble than can be obtained by any other process; in this regard, however, the writer (Mr. Deerr) would remark that the best white sugars of Mauritius made by a defecation process combined with the use of sulphur and phosphoric acid are equal to any that he has seen prepared by the carbonation process."

This leads us to what is, at the present moment, the most urgent problem in cane sugar manufacture; how best to produce white sugar for direct consumption. Looking at the success of the beet sugar factories in turning out white sugar direct from the beetroot juice, the answer at once is double carbonation. So says Mr. Prinsen Geerligs in his latest book, "Cane Sugar and its Manufacture," (1909). At page 159 we read: "If, on the other hand, we want to make sugar for direct consumption . . . . we must have recourse to the double carbonatation process."* He adds that this involves "considerable expense, but this is more than compensated for by the higher price which such sugar fetches when compared with raw sugar."

This is quite definite, and we know that Java has been turning out year after year more white sugar for the Indian market. Two years have barely elapsed since that was written, and now Mr. Prinsen Geerligs has changed his mind. He is not a man to do so without good cause, and everyone interested in cane sugar production ought to weigh carefully what he now says, because white sugar for direct consumption is the sugar of the future, and the makers of it must learn how best to do it. I venture, therefore, apropos of Mr. Deerr's new book, to add this little supplement to it, especially as he leads the way in the passage quoted above.

In the *Journal des Fabricants de Sucre* of 6th July, 1910, there appeared an article by Mr. Prinsen Geerligs entitled, "La fabrication du Sucre Blanc à Java," which was published originally in the *Bulletin de l'Association des Chimistes* of April, 1910. The statements contained in this article are of the highest importance, and deserve the most careful consideration by all interested in the industry of sugar production, whether cane or beet. Mr. Geerligs says that in Java the production of sugar for direct consumption has made enormous progress during the last few years. Two or three thousand tons a year were formerly made for cousumption in the island and its neighbours, but in 1903 Java began to export white sugar to British India, which realised such good profits that the production largely increased. The quantity produced in 1905 was 70,000 tons, and in 1909 250,000 tons, while many factories are still changing

---

* Mr. Deerr prefers the word "Carbonation" as being etymologically the correct form. Mr. Geerligs uses the word "Carbonatation" which is the French form of spelling.

their plant in order to make white sugar in future. The white Java sugar has driven German and Austrian sugars from the Indian markets. This does not mean that the production of raw sugar has decreased; on the contrary, from 700,000 tons of raw sugar produced in 1900, the quantity increased to 900,000 tons in 1905 and a million tons in 1909. In the white sugar factories is to be found all the machinery necessary for double carbonatation, a process which enables them to deliver to the market white sugar of *première qualité*, which keeps well during transport and warehousing in the tropics. But the process is very costly, owing to the extra expenses involved in the use and burning of lime. Also, a factory equipped for the production of white sugar cannot conveniently turn out the raw sugar of colour below No. 16, Dutch Standard, which is alone admitted into the United States and Japan. This is a situation of danger for the white sugar factories, because other countries, British India for instance, might also exclude the importation of white sugar. This has given food for serious thought to Mr. Geerligs and the Java planters, and we now get his solution of the difficulty. The remedy is a radical one, and at the same time starts a new idea—or, rather, the idea now indicated by Mr. Deerr—which, if sound, might revolutionize not only the Java white-sugar factories, but even those in the European beetroot industry. The proposal is to substitute a simple defecation with sulphurous acid for the complicated and costly process of double carbonatation. Mr. Geerligs, in his usual accurate manner, gives full details of the way in which the process should be carried out, but in a review of Mr. Deerr's excellent book I should be trenching on his province if I were to venture further away than I have already gone from my proper duty. It is well, however, apropos of his chapter on carbonation, to indicate the possible approach of some great change of system, a change which, according to his own words quoted above, would apparently not surprise him. My excursion into this matter also shows that Java has gone much further in the adoption of double carbonation than Mr. Deerr imagines.

After a full description of the method to be adopted, Mr. Geerligs concludes with the statement that "the quality of the sugar produced by the system here described differs in no way from that produced by carbonatation; it is as white and preserves its whiteness as long. The sulfitation process has the advantage of extreme simplicity with a very compact plant." Thus the Java planter will be able to turn out first-rate white sugar as well as ordinary raw sugar with the same plant and with very little extra expense. If this is a success it will be a revolution in sugar production of the very first magnitude.

Another word of praise must be given to Mr. Deerr for his very splendid and luminous appendices, extending from page 545 to page

580. Like all reviewers, I also thank him for two admirable indexes. His book, take it all round, is an almost inexhaustible mine of information. After my eulogium on the beautiful coloured picture in Jones and Scard's book I must not fail to admire with equal enthusiasm the wonderful coloured pictures, of Pre-Raphaelite accuracy, with which Mr. Deerr's book abounds.

GEORGE MARTINEAU.

Correspondence.

A FORMOSAN SUGAR CARTEL.

TO THE EDITOR OF THE "INTERNATIONAL SUGAR JOURNAL."

Dear Sir,—You must be aware that the sugar industry in Formosa has made an extraordinary progress under the State protection during these last few years. Last year it yielded about 160,000 tons while the output in the next season is estimated at 250,000 tons, the increase being about 56 per cent., and various plans have been schemed for the extension of the works and the establishment of new ones. The State protection is, however, not the only cause of this progress, but the price of sugar, which has maintained a very high level since a few years ago, has also helped in inducing capital to be invested in this enterprise.

But we are now confronted with the fall of the price of this article due to the unprecedented large crop of European beet sugar, and a sudden check has been put on the further expansion of the industry. It being a protected industry, it has been able to extort large profits in the home market, and has therefore made little effort in paving way for the exportation of its product into foreign countries. The time has now come when the production has increased so much that the home market alone cannot afford to receive the whole sugar, and it must struggle with many difficulties in selling out its surplus product into foreign markets where sugar from the other parts of the world would severely compete with it in face of the abundant supply of this article in this year.

It is interesting to note that our sugar industry is the result of an artificial protection, and if the supply of its product be governed simply by the economical law of supply and demand, its future could not be anything but ruin. This being the case, there is now an agitation here to regulate the production in Formosa by various methods, one of these will be to organize a Cartel among the Formosan sugar firms, defining the amount of sugar to be supplied to the home market and disposing of the surplus by dumping it on oreign markets. With the termination of the Conventional Tariff in July, 1911, the tariff for sugar will be raised to such an extent as to

be almost prohibitive for foreign sugar, and thus the control of the home market would be made much easier. It is however to be regretted that a heavy duty is imposed on a necessity such as sugar. In this country the consumption duty on this article has already attained a very high rate and has greatly interfered with the increase of consumption which according to statistics has remained stationary for ten years though the population is rapidly increasing. When a high tariff is added after next year, and if the above Cartel should succeed, the consumers would lose so much to the advantage of the foreign dealers. Here the usual contradiction of a protective policy ensues; for the principle of self-sufficiency aimed at by it will be quite reversed, as the people under this policy will be compelled to pay a higher price for the protected article instead of being better supplied with it than before the protection arose.

We learn that there is a cry in your country to "return to protection," but the quite opposite one should be needed in this country.

I am, Dear Sir,

Yours faithfully,

Yokohama, K. T.

28th December, 1910.

ABSTRACTS, SCIENTIFIC AND TECHNICAL.*

INVERSION OF CANE SUGAR UNDER THE INFLUENCE OF ACIDS AND NEUTRAL SALTS. *By Noël Deerr. Bull. 35, 1910, Agric. and Chem. Series. Expt. Station, Hawaiian Sugar Planters' Association.*

In the first portion of this valuable bulletin a number of investigations on the effect of various salts on the rate of the inversion of cane sugar by different acids are described. Respecting the action of non-conductors in the presence of salts on the inversion of sucrose, the author comes to the conclusion that "the inversion of cane sugar under the combined influence of glucose and neutral salts does not happen," an opinion that is contrary to the one arrived at by Prinsen Geerligs as the result of his well-known work on the subject. The latter part of the bulletin is of much interest to the scientific manufacturer. It is pointed out that in making white or yellow grocery sugars by the aid of sulphurous and phosphoric acids the degree of acidity permissible without inversion occurring will depend, not only upon the amount of acids used, but also upon the nature and amount of neutral salts present in the juice. Thus a juice heavily limed, then neutralized with sulphurous acid, will contain a large quantity of neutral salts (principally sulphite of lime), and to such a juice more phosphoric acid can be added than if a smaller amount of lime and sulphur had initially been used. With the object of obtaining data bearing more

directly on this point an experiment was made in which varying amounts of an N/10 solution of phosphoric acid were added to 25 c.c. of a 20 per cent. solution of cane sugar, followed by different amounts of N/10 caustic soda, the whole made up to 50 c.c. and heated on the water-bath for 30 minutes. After cooling, the solutions were polarized, and the point at which inversion had stopped was noted. In this way it was found that, depending upon the neutral salt present, inversion may begin with an amount of free acid varying from 8 to 40 c.c. of N/10 phosphoric acid per 100 c.c. of the solution. A similar experiment, made with a neutralized cane juice, showed that inversion was first detectable in the presence of 6 c.c. of N/10 phosphoric acid. In a final experiment the amounts of salts and acids were more comparable with the conditions that obtain in practice. The largest amount of sulphur used in cane factories reaches 5 lbs. per 1000 imperial gallons of juice, which quantity corresponds to a concentration of 0·03 N, whilst the minimum amount may be about one-third of this. Accordingly a juice was limed to phenolphthalein alkalinity, then sodium sulphite added to make the concentration of this salt equal to 0·01 to 0·04 N. To these sulphited juices were added increasing amounts of N/10 phosphoric acid solution, then the point at which inversion commenced after heating for 30 minutes at 97-98° C. was determined, when the following figures were obtained:—

Concentration of sodium sulphite.	Concentration of phosphoric acid at which inversion was detectable.
0·01 N.	24 c.c. of N/10 acid per 100 c.c.
0·02 N.	42 ,, ,, ,,
0·04 N.	68 ,, ,, ,,

Estimation of the Sulphurous Acid Content of Cane Juices.

By J. J. Hazewinkel and J. J. Robijn. Archief. Suikerind. Nederl.-Ind. (Java), 1910, 18, 590-598.

It has been conclusively shown in the case of beetroot juices that direct titration with standard iodine solution is capable of giving the true sulphurous acid content. But for cane juices, which contain glucose, and in which the organic substances are not the same as in beet juices, this, the authors believe, has not been clearly established, it being quite conceivable that the iodine should attack other bodies present than sulphurous acid. It is pointed out that in the volumetric titration of free sulphurous acid in aqueous solution reliable results are only obtained when the solution containing sulphurous acid is allowed to flow into the iodine solution; and that if, on the contrary, the iodine solution is run into the sulphurous acid solution trustworthy results are not obtained unless very weak solutions are used, as Bunsen and others have shown. In the first series of experiments described in this article, a series of sulphurous acid solutions, of concentrations 0·023 and 0·051 per cent., in (*a*) water alone, and (*b*) imitated juices (molasses solutions to which sugar had been added

to give 18° Brix and 81·5 purity), were run into excess of N/10 iodine solution, and this back-titrated with N/10 sodium thiosulphate solution, starch solution as indicator being added towards the end of the titration when most of the thiosulphate required had been run in. From the tabulated results it is seen that there is no appreciable difference between the figures obtained for (*a*) aqueous solutions and (*b*) for juices, thus indicating that the constituents of the juice have but little effect upon the iodine under the prescribed conditions of the determination. In a similar series, also with (*a*) water and (*b*) juice, in which the sulphurous acid and the excess of iodine used were varied, a less amount of sulphurous acid was found in the case of the aqueous solution than with the juice. These differences, however, were not great, although they indicated that in order to obtain accurate results the sulphurous acid must be diluted sufficiently. Summarizing this investigation, it is shown that (1) the error in titrating juices is greater than with aqueous solutions, which is due rather to the darker colour of the former making the end-point less sharp than to any action of the iodine on the juice constituents; and (2) that in order to obtain reliable and concordant results the juice must be diluted until it has a sulphurous acid content of not more than 0·04 per cent.

Some Formulae for Massecuite Calculations.* *By K. Tennstedt. Centr. Zuckerind., 1910, 18, 1235-1238.*

In the sugar factory or refinery it is desirable for the chemist from time to time to determine the possible yield of crystallizable sugar from the massecuite, and in doing this the Neumann, Schneider, and Hulla-Suchomel formulae are the most generally used. In addition to these, the author has worked out another formula (see this *Jl.*, 1910, 152), which is more applicable to first massecuites and raw sugars. He now deduces yet other formulae for the control of both first and after-product massecuites, which are applicable under various conditions. In these a, b, c, k, = respectively the sugar content, the Brix, the quotient, and the crystal content of the massecuite; l = the number of parts of sugar dissolved in one part of water in the mother-syrup, u = the coefficient of supersaturation, s = the coefficient of saturation, $l\,t^\circ$ = the number of parts of sugar dissolved in one part of water in a saturated solution of pure sugar at t° (found from Herzfeld's table), and d and p = the quotient and sugar contents respectively of the mother-syrup. The first formula given allows of the rapid

* In a subsequent article, Dr. Claassen (*Centr. Zuckerind.*, 1910, *18*, 1266) criticises these massecuite formulae by pointing out that all formulae for massecuite calculations must be based on *real* purity values, and not on the purity as found from the Brix reading, since the ratio between the real and apparent contents of water is never constant. Replying to this (*Ibid.*, 1910, *18*, 1235) Tennstedt expresses his agreement with Claassen, regretting that he had neglected to emphasize that it is essential to use the Brix determined by desiccation, and not the apparent Brix value as found by the spindle.

determination of the water content to which a strike of known purity must be boiled to give a certain amount of crystal, which is subsequently to be separated at a certain machining temperature: $d = 100\frac{a - k}{b - k}$ or $b = \frac{100\ (k + 100\ l)}{100\ l + c}$. In order to find the quotient of the spun-out syrup, the next formula, which is deduced from that of Hulla-Suchomel, should be used: $d = 100\frac{a - k}{b - k}$. Or for the same purpose the following is applicable: $\frac{bc - 100\,k}{b - k}$. From the formula for the Brix of the massecuite a "saturation formula" may be found. since when a syrup is saturated, $k = o$ and $c = a$: $b = \frac{10{,}000\ l}{100\,l + d}$. To express the water content of a massecuite the author gives: $w = \frac{100\ d}{100\ l + d}$.* For the number of parts of sugar dissolved in one part of water in the mother-syrup, $l = \frac{a - K}{100 - b}$. And for the coefficient of supersaturation, $u = \frac{a - K}{lt^\circ\ (100 - b)}$; or

$$u = \frac{b\,d\ (100 - c)}{l\,t^\circ\ [10{,}000\ (100 - d) - 100\ b\ (100 - d)\ ]}.$$

In the original article the author illustrates the application of each of these new formulae by examples from actual practice.

Use of the Inversion Tube for all Polarimetric Observations.

By H. Pellet. Annal. Chem. Analytique, 1910, 15, 376-379.

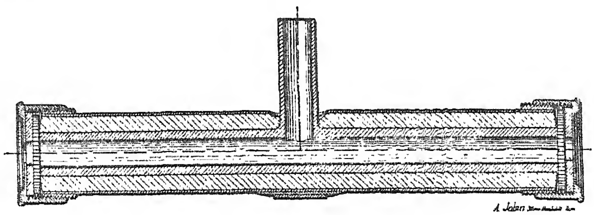
Tubes for making polarimetric observations may be closed in various ways, viz., (1) by a screw, as is generally adopted by the German makers; (2) by a spring, used for many years by certain French firms; and (3) by the device proposed by Landolt, which consists of a metal cap covering the glass discs. In using the ordinary tube, by whichever method it may be closed, there are certain inconveniences, such as the frequent replacing of the glass discs to clean them; and the trouble involved in filling the tube. As means of overcoming these inconveniences the author advocates replacing all the so-called "simple tubes" by the water-jacketed inversion tube (see illustration)† for *all* polarimetric observations both direct and indirect. Such a tube is easy to fill by the aperture in the middle; it can be easily rinsed; the glass discs once in position need not be replaced; there is no trouble with bubbles of air; and all readings

---

* Claassen in his "Beet Sugar Manufacture" expresses this formula as follows: $w = \frac{q}{L\,t\,.\,c + 0{\cdot}01\ q}$, in which q = the quotient, $L\,t$ = the ratio of saturation of a pure sugar solution at t°, and c = the coefficient of saturation.

† Obtainable from the firm of A. Jobin, 31, rue Humboldt, Paris, the well-known optical instrument makers.

can be made at the same temperature, either 20°C. in Europe, or 25 or 30°C. in the tropics. By making a mark on one end of the tube it can always be placed in the same position in the instrument, so that the same disc is invariably at the same end of the tube, relative to the



source of light. If this is so, and the same intensity of light is always used, and the polarimeter is always in the same position, then perfectly identical conditions will always obtain.

NEW METHOD OF DETERMINING CANE SUGAR IN THE PRESENCE OF OTHER SUGARS. *By A. Jolles. Zeitsch. Unters. Nahr. Genussm., 1910, 20, 631-638,* and *Österr.-Ungar, Zeitsch. Zucker-ind., 1910, 39, 698-703.*

It is well known that the optical activity of certain sugars, including invert sugar (dextrose and levulose), is destroyed by heating with alkali, while the sucrose (cane sugar) and raffinose, if present, is unaffected by such treatment, provided certain conditions as to concentration and time be observed. On this principle the author has devised a method of determining sucrose, and also raffinose when present, in presence of substances containing other sugars. The precautions to be observed are that the solution under examination should be so diluted that not more than 2 per cent. of sucrose is present, and that the alkalinity should be about N/10. The alkaline solution may either be boiled in a flask attached to a reflux condenser for three-quarters of an hour, or in a boiling water-bath *in vacuo* for the same period of time; or again it may be kept at 37° C. for 24 hours, which latter method is stated to give the most satisfactory results and the minimum decoloration. It is stated that the results obtained by this new procedure, agree well with those found by the ordinary method of determining sucrose used in sugar analysis.

BIOCHEMICAL INVESTIGATIONS ON HAWAIIAN SOILS WITH ESPECIAL REFERENCE TO FERTILIZING WITH MOLASSES. *By S. S. Peck. Bull. No. 34, 1910, Agric. and Chem. Series, Expt. Station, Hawaiian Sugar Planters' Assoc.*

In Mauritius it has been found that decidedly increased gains in the cane crop resulted from the application of about two pints of molasses to

each cane hole, when digging two months previous to planting the seed. It was further observed that this increased yield was much in excess of the beneficial effect obtainable from the nitrogen, potash, and phosphoric acid of the molasses, these fertilizing constituents being present in an amount too small to have any very appreciable influence. Somewhat similar results were obtained at Antigua, and also in Java. It is of course well known that, owing to the influence of certain definite micro-organisms, four predominating transformations of the nitrogenous substance of the soil are constantly occurring, viz., ammonification, nitrification, nitrogen-fixation and denitrification, the first three of which from an agricultural point of view may be considered as constructive, and the last one as destructive. Carbohydrates have been observed to exert a distinct influence on the activity of these transformations. Thus Lipman found that dextrose depresses the ammonification of peptone quite considerably; whilst A. Koch demonstrated that nitrogen-fixing organisms are stimulated by the presence of sucrose, although he found that the soil nitrogen is diminished when molasses is used as the source of carbohydrate. In this Bulletin are described some very instructive experiments on the influence of carbohydrates, in the form of molasses and of dextrose, on ammonification, nitrification, nitrogen-fixation, and denitrification, using soils from different parts of a Hawaiian cane plantation. As the result, it is indicated that the application of molasses may produce beneficial effects only when applied to fallow land, or at least when applied to the soil some weeks previous to planting the cane, in which case it stimulates the nitrogen-fixing bacteria, contributing in this way to the elaboration of nitrogen in a readily assimilable form. When, however, the molasses is applied to land on which cane is growing, and on which a nitrogenous fertilizer has been used, it will act harmfully by preventing the formation of nitrates. Nitrogen-fixing bacteria do not act well in the presence of a sufficient supply of available nitrogen, and it is only when deprived of such a source of nutriment, and in the presence of a proper supply of organic matter as a source of the necessary energy, that they utilize the nitrogen of the air and fix it in the soil. For this reason it is apparent that when molasses is placed on land on which artificial nitrogenous dressings have been supplied, this one beneficial property of the sugars of the molasses will be nullified. A number of other experiments on the transformations taking place in Hawaiian soils at depths of one to four feet are also described.

The plans for the projected sugar refinery at St. John's, New Brunswick, are now complete and the construction is likely to be begun during the coming spring.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E. Chartered Patent Agent, 6, Lord Street, Liverpool; 77, Market Street, Bradford; and 285, High Holborn, London.

ENGLISH.—Applications.

30253. T. Farmer, Jun., London. *Improved rolling mill for crushing sugar cane.* 30th December, 1910.

133. E. Bebien. *Apparatus for the continual fabrication by cold process of sugar syrup.* (Complete specification.) 3rd January, 1911.

1027. W. Mackie. *Hydraulic pressure regulating gear for sugar cane mills and the like.* (Complete specification.) 14th January, 1911.

GERMAN.—Abridgments.

228409. Wilhelm Bode, of Oschersleben-on-Bode. *Apparatus for discharging centrifugals, more particularly for the sugar industry.* 26th February, 1910. This arrangement consists of scrapers which are permanently located in the drum of the centrifugal, and formed of thin wires or knives, sharpened on one side and fitting closely to the walls of the drum and held together by wire or flat steel loops or yokes and fixed in a ring in the upper part of the drum, on which ring a brake mechanism acts in known manner.

228977. Soc. Anonyme de la Raffinerie A. Sommer, of Paris. *A machine for feeding sugar bars to disintegrating machines and the like and removing them therefrom.* 3rd November, 1909. A feeding apparatus which engages the sugar bars arranged in succession on a supporting table and places them on a conveyor belt, is combined with said endless conveyor belt which is constantly in motion, and also with a separate device for turning the bars over and a device for dividing the bars into groups, by means of which their delivery in given numbers to several predetermined places can be effected.

WEEKLY STATEMENT OF COMPARATIVE

For the Fifty-two weeks of 1910 compared

	German Beetroot 88 o/o Prompt, free on board.						French Crystals. No. 3. c. f. i.			Java afloat. No. 15 and 16.		
	1910.		1909.		1908.		1910.	1909.	1908.	1910.	1909.	1908.
an. 7..	12/4	12/8½	10/1	10/1¼	9/11¼	9/10	Nom.	Nom.	Nom.	13/4½	10/9	10/9
14..	12/8½	13/0½	10/1¼	10/1¼	9/10½	9/10	,,	,,	,,	13/7½	10/10½	10/9
21..	13/0½	12/8½	10/1¼	10/2½	9/10	9/10	,,	,,	,,	13/7½	10/10½	10/7½
28..	12/8½	12/10½	10/2½	10/1½	9/10	9/10	,,	,,	,,	13/6	10/10½	10/7½
Feb. 4..	12/10½	12/10½	10/1½	10/-	9/10¾	9/11	15/3¾	,,	,,	13/6	10/10½	10/9
11..	12/10½	13/-	10/-	10/1	9/11	9/10¼	15/4½	,,	,,	13/7½	10/10½	10/9
18..	13/-	13/4	10/1	10/0¼	9/10¼	9/10¼	15/7½	,,	,,	13/7½	10/10½	10/7½
25..	13/4	13/10½	10/0¼	10/1½	9/10¼	10/1	15/9¾	,,	,,	14/4½	11/-	10/9
March 4.	13/10½	14/6½	10/1½	10/2¼	10/1	10/3½	16/6	,,	,,	15/-	11/-	11/3
11..	14/6½	14/6¼	10/2¼	10/3½	10/3½	10/7	16/6	,,	,,	15/1½	11/1½	11/4½
18..	14/6¼	14/6	10/3½	10/6	10/7¼	11/3	16/6	12/6¾	,,	15/1½	11/3	11/10½
25..	14/6	14/9	10/6	10/5¼	11/3	11/4½	Nom.	Nom.	,,	15/1½	11/3	12/-
April 1..	14/9	14/9½	10/5¼	10/4½	11/4½	11/3¾	,,	,,	,,	15/1½	11/4½	12/-
8..	14/9½	14/7	10/4½	10/4	11/3¾	11/6¾	,,	,,	,,	15/1½	11/6	12/1½
15..	14/7	14/1½	10/4	10/4½	11/6¾	11/8¼	,,	,,	,,	14/9	11/6	12/1½
22..	14/1½	14/5½	10/4½	10/5½	11/8¼	11/10½	,,	,,	13/8¼	14/9	11/6	12/3
29..	14/5½	14/6	10/5½	10/3½	11/10½	11/9	,,	,,	13/7½	14/7½	11/6	12/3
May 6..	14/6	14/10	10/3½	10/4¾	11/9	11/8½	,,	,,	13/7½	14/9	11/6	12/3
13..	14/10	14/8½	10/4¾	10/7¼	11/8½	11/7½	,,	,,	13/6¾	14/9	11/6	12/6
20..	14/8½	14/10¾	10/7¼	10/8	11/7½	11/2	,,	,,	13/4½	14/9	11/6	12/3
27..	14/10¾	14/9½	10/8	10/8½	11/2	11/4	,,	,,	13/4½	14/9	11/6	12/3
June 3..	14/9½	14/4	10/8½	10/7½	11/4¾	11/3½	,,	,,	13/-	14/7½	11/6	12/3
10..	14/4	14/6½	10/7½	10/6	11/3½	11/4½	,,	,,	13/-	14/7½	11/6	12/3
17..	14/6½	14/3	10/6	10/5½	11/4½	11/0¼	,,	12/8¼	12/4½	14/6	11/6	12/3
24..	14/3	14/7¼	10/5½	10/5½	11/0¼	10/11	,,	12/9	12/5¼	14/4½	11/6	12/-
July 1..	14/7½	14/9	10/5½	10/5¾	10/11	11/5	,,	12/7½	12/7½	14/4½	11/6	12/1
8..	14/9	14/10	10/5¾	10/5½	11/5	11/3¼	,,	12/7½	12/10½	14/6	11/6	12/3½
15..	14/10	14/9½	10/5½	10/5¼	11/3¼	11/-	,,	12/7½	12/10½	14/6	11/6	12/3½
22..	14/9½	14/10½	10/5¼	10/5¼	11/-	10/7¼	,,	12/7½	12/6	14/6	11/4½	12/1½
29..	14/10½	14/9¾	10/5¼	10/8	10/7½	10/6	,,	13/-	12/4½	14/6	11/4½	11/7
Aug. 5..	14/9¾	14/10½	10/8	10/10¼	10/6	10/1½	,,	Nom.	Nom.	14/7½	11/6	11/4½
12..	14/10½	14/10¼	10/10½	11/3	10/1½	10/0½	,,	13/7½	,,	14/6	11/9	11/11½
19..	14/10¼	14/10½	11/3	11/7	10/0½	9/8½	,,	Nom.	,,	14/6	11/10½	11/-
26..	14/10½	14/7½	11/7	11/6	9/8½	9/5½	,,	,,	,,	14/3	11/10½	10/9
Sept. 2..	14/7½	13/-	11/6	11/9	9/5½	9/8¼	,,	,,	,,	14/-	11/10½	10/6
9..	13/-	12/6	11/9	11/10¼	9/8¼	9/8½	,,	13/8¼	,,	13/3	12/-	10/6
16..	12/6	11/11	11/10½	11/8½	9/8½	9/9	,,	13/11¼	,,	12/6	12/-	10/9
23..	11/11½	11/7	11/8½	11/9	9/9	9/10	,,	13/11¼	,,	12/6	12/0¾	10/9
30..	11/7	10/1	11/9	14/3	9/10	9/6¼	,,	13/11¼	,,	11/6	12/1½	10/9
Oct. 7..	10/1	9/9¼	10/10½	11/3	9/6¼	9/7¾	,,	Nom.	,,	11/-	12/1½	10/9
14..	9/9¼	9/6¼	11/3	11/0¾	9/7¾	9/10¼	,,	13/6	,,	10/6	12/3	11/-
21..	9/6¼	9/2	11/0¾	11/0½	9/10¼	10/4½	,,	13/1½	,,	10/4½	12/3	11/3
28..	9/2	8/8½	11/0½	11/9	10/4½	9/11	,,	13/7½	,,	10/-	12/7½	11/1½
Nov. 4..	8/8½	9/-	11/9	11/9	9/11	10/1	,,	13/9	,,	10/-	12/9	11/1½
11..	9/-	8/11¼	11/9	12/4½	10/1	10/2	,,	Nom.	,,	10/1½	13/3	11/1½
18..	8/11¼	9/0¾	12/4½	12/5½	10/2	10/3	,,	,,	,,	10/1½	13/4½	11/1½
25..	9/0¾	9/0¼	12/5½	12/6	10/3	10/2¼	,,	,,	,,	10/1½	13/4½	11/1½
Dec. 2..	9/0¼	9/0¾	12/6	12/7½	10/2¼	10/1	,,	,,	,,	10/3	13/6	11/1½
9..	9/0¾	9/1	12/7½	12/5	10/1¼	10/-	,,	,,	,,	10/3	13/4½	11/1½
16..	9/1	9/0½	12/5	12/4¾	10/-	10/0½	,,	,,	,,	10/3	13/3	11/1½
23..	9/0½	8/10½	12/4¾	12/2	10/0½	10/1¼	,,	,,	,,	10/3	13/1½	10/10½
30..	8/10½	8/11¼	12/2	12/4	10/1¼	10/1	,,	,,	,,	10/3	13/-	10/9

PRICES OF RAW AND REFINED SUGAR,

with those of the two previous years.

	Tate's Cubes No. 1.			Tate's Cubes, No. 2.			First Marks German Granulated f. o. b.			Say's Cubes f. o. b.			German & Austrian † Cubes f. o. b.		
	1910.	1909.	1908.	1910.	1909.	1908.	1910.	1909.	1908.	1910.	1909.	1908.	1910.	1909.	1908.
Jan. 7..	21/1½	18/3	19/10½	20/3	17/3	19/-	14/7½	12/2¼	11/6¾	17/7½	14/9	14/3	16/7½	13/10½	13/6½
14..	21/9	18/4½	19/10½	20/10½	17/4½	19/-	15/-	12/2¼	11/6¾	17/10½	14/9	14/3	17/1½	14/-	13/6
21..	21/6	18/4½	19/10½	20/7½	17/4½	19/-	14/9¾	12/3¾	11/6¾	17/10½	14/9	14/1½	17/-	14/-	13/3
28..	21/6	18/6	19/10½	20/6	17/6	19/-	15/0¾	12/4½	11/8¼	17/10½	14/9	14/-	16/9	14/-	13/6
Feb. 4..	21/6	18/4½	20/-	20/6	17/4½	19/1½	15/0¾	12/3	11/9¾	17/10½	14/9	14/-	16/11¼	13/10½	13/7½
11..	21/6	18/4½	20/-	20/6	17/4½	19/1½	15/2¼	12/3¾	11/8¼	17/10½	14/7½	14/-	17/-	13/10½	13/6¾
18..	21/9	18/4½	19/10½	20/9	17/4½	19/-	15/5¼	12/3¾	11/8¼	17/10½	14/7½	14/-	17/3	13/10½	13/4½
25..	22/3	18/6	20/-	21/3	17/6	19/1½	15/11¼	12/4½	11/10½	18/9	14/9	14/-	18/-	14/-	13/7½
March 4..	23/-	18/8	20/3	22/0	17/7½	19/4½	16/6	12/4½	12/1½	19/-	14/9	14/3	18/6	13/10½	13/10½
11..	23/3	18/9	20/7½	22/3	17/9	19/9	16/6	12/5¼	12/3½	19/-	14/9	14/6	18/6	14/1½	14/3
18..	23/3	18/10½	21/-	22/3	17/10½	20/1½	16/5¼	12/6	13/-	19/-	14/9	14/10½	18/6	14/1½	14/10½
25..	23/3	18/10½	21/-	22/3	17/10½	20/1½	16/7½	12/3¾	12/11¼	19/3	15/-	15/-	18/7½	14/1½	14/10½
April 1..	23/4½	18/9	21/3	22/4½	17/9	20/4½	16/9¾	12/2¼	12/9	19/4½	15/-	15/3	18/10½	14/1½	14/10½
8..	23/4½	18/9	21/3	22/4½	17/9	20/4½	16/9	12/6	13/-	19/7½	15/-	15/4½	18/10½	14/1½	15/-
15..	23/1½	18/10½	21/7½	22/1½	18/-	20/9	16/3¾	12/6¾	13/3	19/7½	15/-	15/4½	18/7½	14/1½	15/1½
22..	23/10½	18/10½	21/9	21/10¼	18/-	20/10½	16/9	12/3¾	13/6	19/7½	15/-	15/7½	18/9	14/1½	15/3
29..	23/10½	18/10½	21/9	22/1½	18/-	20/10½	16/10½	12/1½	13/4½	19/7½	15/-	15/9	18/10½	14/1½	15/4½
May 6..	23/1½	18/7½	21/9	22/4½	17/9	20/10½	17/-	12/3	13/4½	20/1½	15/-	15/9	19/-	14/1½	15/4½
13..	23/3	18/10½	21/9	22/6	18/-	20/10½	17/-	12/6	13/4½	20/1½	15/1½	15/9	19/1½	14/4½	15/4½
20..	23/3	18/10½	19/3	22/6	18/-	18/3	17/2¼	12/7½	13/-	20/4½	15/1½	15/9	19/2¼	14/4½	15/1½
27..	23/6	19/-	19/-	22/9	18/1½	18/-	17/2¼	12/8¼	13/3	20/7½	15/1½	15/4½	19/4½	14/5¼	15/-
June 3..	23/3	19/-	19/-	22/6	18/1½	18/-	16/8¼	12/8¼	13/0¾	20/7½	15/1½	15/4½	19/1½	14/5¼	14/10
10..	23/-	19/-	19/-	22/3	18/1½	18/3	16/9¾	12/7½	13/2¼	20/7½	15/1½	15/3	19/-	14/4½	15/-
17..	22/9	18/10½	18/9	22/-	18/-	18/-	16/6	12/6¾	12/8¼	20/7½	15/1½	15/3	18/10½	14/4½	14/9½
24..	22/9	18/9	18/7½	22/-	17/10½	17/10½	16/9¾	12/7½	12/5¼	20/7½	15/1½	15/3	18/9	14/3	14/7½
July 1..	22/9	18/9	18/9	22/-	17/10½	18/-	16/9¾	12/6¾	12/10½	20/7½	15/-	15/-	18/9	14/3	14/10½
8..	22/9	18/9	19/4½	22/-	17/10½	18/7½	16/10½	12/6	12/9¾	20/7½	14/9	15/3	18/10½	14/1½	14/10½
15..	22/9	18/10½	19/3	22/-	18/-	18/6	16/8¼	12/6	12/7½	20/7½	14/9	15/3	18/10½	14/1½	14/9
22..	22/9	18/10½	19/-	22/-	18/-	18/3	16/9¾	12/6	12/4½	20/7½	14/10½	15/-	18/10½	14/3	14/4½
29..	22/9	19/1½	18/10½	22/3	18/3	18/1½	16/10½	12/9	12/2¼	20/7½	14/10½	15/-	19/1½	14/6	14/4½
Aug. 5..	22/9	19/3	18/9	22/3	18/4½	18/-	17/-	13/-	11/9	20/7½	15/1½	15/-	19/1½	14/6	14/1½
12..	23/-	19/9	18/6	22/6	18/10	17/9	17/5¼	13/6	11/10½	20/7½	16/-	14/9	19/1¼	14/10½	14/-
19..	23/-	20/-	18/3	22/6	19/1½	17/6	17/4½	13/9	11/9	20/7½	16/-	14/9	19/3	15/-	13/10½
26..	23/-	20/-	18/-	22/6	19/1½	17/3	17/3	13/8¼	11/7½	20/7½	16/-	14/3	19/3	15/-	13/9
Sept. 2..	22/6	20/-	18/-	22/-	19/1½	17/3	16/7½	13/9¾	11/10½	20/7½	16/-	14/6	19/3	15/-	13/9
9..	22/6	20/3	18/-	22/-	19/4½	17/3	16/4½	13/11¼	12/-	20/7½	16/-	14/7½	18/10½	15/3	13/9
16..	21/6	20/3	18/-	21/-	19/4½	17/3	15/3	13/10½	12/0¾	20/7½	16/3	14/9	18/-	15/3	13/7½
23..	21/6	19/9	18/-	21/-	18/10½	17/3	14/7½	13/9	12/3	20/7½	16/3	15/-	17/6	15/0¾	13/9
30..	21/-	19/9	18/-	20/6	18/10½	17/3	13/9	14/-	12/0¾	20/7½	16/3	15/-	16/9	15/-	13/6
Oct. 7..	20/-	19/9	17/9	19/6	18/10½	17/-	12/3	13/9	11/10½	16/10½	16/3	14/-	15/2¼	15/1½	13/3
14..	19/6	20/-	18/-	19/-	19/1½	17/3	11/10	13/7½	12/-	15/9	15/9	14/1½	14/8¼	15/3	13/9
21..	19/-	19/6	18/4½	18/6	18/7½	17/7	11/8¼	13/1½	12/3¾	15/9	15/9	14/6	14/6	15/1½	14/1½
28..	18/6	20/-	18/1½	18/-	19/1½	17/4	11/1	13/7½	11/9	15/9	15/10½	14/6	13/3	15/7½	13/9
Nov. 4..	17/9	19/10½	18/3	17/3	19/-	17/6	11/3	13/6	11/10½	14/10½	15/10½	14/3	13/4½	15/7½	13/9
11..	17/9	20/6	18/3	17/3	19/7½	17/6	11/3	14/1½	12/-	15/1½	16/4½	14/6	13/3	16/3	14/1½
18..	17/9	20/9	18/4½	17/3	19/10½	17/7½	11/3	14/6	12/-	15/3	16/10½	14/6	13/4½	16/6	14/-
25..	17/9	21/3	18/6	17/3	20/4½	17/9	11/3	14/6¾	12/-	15/3	17/4½	14/6	13/4½	16/6	14/-
Dec. 2..	17/6	21/3	18/4½	17/-	20/4½	17/7½	11/2¼	14/6¾	11/10½	15/3	17/4½	14/6	13/4½	16/9	13/10½
9..	17/6	21/1½	18/3	17/-	20/3	17/6	11/2¼	14/3¾	11/8¼	15/3	17/4½	14/6	13/3	16/6	13/7
16..	17/6	20/10½	18/3	17/-	20/-	17/6	11/1½	14/3¾	11/9¾	15/3	17/4½	14/6	13/1½	16/4½	13/9
23..	17/6	20/10½	18/3	17/-	20/-	17/6	10/9¾	14/2¼	12/-	15/3	17/4½	14/9	13/1½	16/4½	13/9
30..	17/3	20/10½	18/3	16/9	20/-	17/6	11/-	14/2¼	12/2¼	15/3	17/4½	14/9	13/-	16/4½	13/10½

† Basis average PGR, EAR, SZG.

H. H. HANCOCK & Co., 10 & 11, Mincing Lane, London, E.C.

UNITED KINGDOM.

IMPORTS AND EXPORTS OF SUGAR
To End of January, 1910 and 1911.

IMPORTS.

Unrefined Sugars.	1910. Tons.*	1911. Tons.*	1910. £	1911. £
Russia	....	....	....	....
Germany	23,990	48,283	300,588	461,531
Netherlands	1,040	1,054	12,280	9,501
Belgium	725	1,091	8,860	10,074
France	57	17	873	138
Austria-Hungary	13,019	8,913	167,544	87,165
Java	....	....	....	....
Cuba	....	....	....	....
Dutch Guiana	947	1,125	13,997	15,322
Hayti and San Domingo	788	....	9,829	....
Mexico	80	....	930	..
Peru	3,573	4,919	41,820	43,398
Brazil	7,194	554	82,361	4,045
Mauritius	1,542	4,928	16,358	45,292
British India	....	....	....	....
Straits Settlements	....	....	....	....
Br. West Indian Islands, Br. Guiana & Br. Honduras	10,976	7,475	146,147	91,022
Other Countries	55	2,345	717	20,312
Total Raw Sugars	63,988	80,705	802,304	787,801
Refined Sugars.				
Russia	59	3,889	910	43,635
Germany	36,617	38,078	542,585	478,908
Holland	8,669	11,426	130,663	151,342
Belgium	2,993	3,090	46,664	40,396
France	1,091	603	16,023	8,787
Austria-Hungary	20,682	25,016	313,574	321,297
Other Countries	2,836	51	44,417	590
Total Refined Sugars	72,948	82,153	1,094,836	1,044,955
Molasses	12,798	7,423	61,533	40,527
Total Imports	149,734	170,281	1,958,673	1,873,283

EXPORTS.

British Refined Sugars.	Tons.	Tons.	£	£
Denmark	338	371	4,526	4,059
Netherlands	293	279	4,468	3,660
Portugal, Azores, & Madeira	149	143	1,826	1,585
Italy	26	232	319	2,736
Canada	173	545	2,750	7,843
Other Countries	630	1,272	11,119	20,011
	1,609	2,842	25,008	39,894
Foreign & Colonial Sugars				
Refined and Candy	45	101	809	1,478
Unrefined	213	1,820	2,937	19,279
Various Mixed in Bond	....	....	....	....
Molasses	60	6	437	42
Total Exports	1,927	4,769	29,191	60,693

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1911. Tons.		1910. Tons.
Total Receipts January 1st to 26th. ..	102,143	..	124,946
Receipts of Refined ,, ,, ...	—	..	—
Deliveries ,, ,, ...	102,143	..	128,296
Importers' Stocks, Jan. 25th	None	..	None
Total Stocks, Feb. 1st, ...	64,000	..	123,810
Stocks in Cuba, ,, ...	48,000	..	104,000
	1910.		1909.
Total Consumption for twelve months ..	3,350,355	..	3,257,660

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR FOR 1908, 1909 AND 1910.

(Tons of 2,240lbs.)	1908. Tons.		1909. Tons.		1910. Tons.
Exports	906,013	..	1,443,562	..	1,733,164
Stocks	2,976	..	314	..	....
	908,989	..	1,443,876	..	1,733,164
Local Consumption (11 months).	62,287	..	69,706	..	71,185
	971,276	..	1,513,582	..	1,804,349
Stock on 1st January (old crop)..	9,318	..	....	..	....
Total Production	961,958		1,513,582		1,804,349

Havana, 30th November, 1910. J. GUMA.—F. MEJER.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION OF SUGAR FOR ONE MONTH ENDING JANUARY 31ST.

	Imports. 1909. Tons.		Imports. 1910. Tons.		Imports. 1911. Tons.	Exports (Foreign). 1909. Tons.		1910. Tons.		1911. Tons.
Refined	70,829	..	72,948	..	82,153	46	..	45	..	101
Raw	62,063	..	63,988	..	80,705	149	..	213	..	1,820
Molasses	10,978	..	12,798	..	7,423	9	..	60	..	6
	143,870		149,734		170,281	204		318		1,927

	Home Consumption. 1909. Tons.		1910. Tons.		1911. Tons.
Refined	70,879	..	69,298	..	76,328
Refined (in Bond) in the United Kingdom........	46,605	..	45,235	..	48,921
Raw	10,061	..	13,760	..	11,324
Molasses	11,781	..	11,461	..	11,941
Molasses, manufactured (in Bond) in U.K........	6,191	..	6,506	..	6,153
Total..........................	145,517	..	146,260	..	154,667
Less Exports of British Refined..................	1,950	..	1,250	..	2,000
	143,567		145,010		152,667

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, JAN. 1ST TO 28TH, COMPARED WITH PREVIOUS YEARS.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1911.
131,250	1,787,120	574,240	865,100	352,050	3,709,760

	1910.	1909.	1908.	1907.
Totals ..	..3,083,640..	3,470,130..	3,500,320..	3,517,880

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING DECEMBER 31ST, IN THOUSANDS OF TONS.

(Licht's Circular.)

Great Britain.	Germany.	France.	Austria-Hungary	Holland, Belgium, &c.	Total 1910.	Total 1909.	Total 1908.
1911	1300	707	603	232	4752	4732	4534

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1910-1911. Tons.	1909-1910. Tons.	1908-1909. Tons.	1907-1908. Tons.
Germany	2,602,000 ..	2,027,000 ..	2,082,848 ..	2,129,597
Austria	1,570,000 ..	1,257,000 ..	1,398,588 ..	1,424,657
France	740,000 ..	801,000 ..	807,059 ..	727,712
Russia	2,115,000 ..	1,145,000 ..	1,257,387 ..	1,410,000
Belgium	285,000 ..	250,000 ..	258,339 ..	232,352
Holland	225,000 ..	198,000 ..	214,344 ..	175,184
Other Countries .	590,000 ..	460,000 ..	525,300 ..	462,772
	8,127,000	6,138,000	6,543,865	6,562,274

THE

INTERNATIONAL SUGAR JOURNAL.

No. 147. MARCH, 1911. Vol. XIII.

☞ All communications to be addressed to the Editor, Office of "The Sugar Cane," Altrincham, near Manchester. All Advertisements to be sent direct.

☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

Cheques and Postal Orders to be made payable to NORMAN RODGER, Altrincham.

The Editor will be glad to consider any MSS. sent to him for insertion in this Journal and will endeavour to return the same if unsuitable; but he cannot undertake to be responsible for them unless a stamped addressed envelope is enclosed.

NOTES AND COMMENTS.

Abnormal Yields of Cane.

A statement recently appeared in *Tropical Life* from Mr. F. I. Scard that he had seen over sixty tons of Bourbon cane per acre produced on new land in British Guiana, and further, that the average yield is not more than 25 tons per acre. *The Louisiana Planter* took exception to these figures, quoting the authority of Sir William Russell to the effect that a yield of 35 to 40 tons of cane per acre was a large yield. "On the other hand," said the Louisiana organ, "all such yields in British Guiana are as a rule estimates only, the transportation of all of the cane by water to the sugar factories rendering the ordinary method of ascertaining weights by weigh bridge or scale weighing impracticable. In fact, we think that the delay in the development of the central factory industry in British Guiana is based largely upon the fact that they have no definite way of ascertaining the exact weight of sugar canes, thus leaving the planters who have only small areas of land in cultivation without sufficient data as to the positive yield, to inspire them to such effort as is necessary to secure the best results."

But as a matter of fact we learn from Mr. Scard that the statement as to cane yield may be taken as correct. The figures for British

Guiana were based on actual weights, not estimates. They were obtained from representative estates, on which the weight of cane was arrived at by weighing as a part of the daily routine the megass and adding that to the weight of juice. As regards the alleged delay in the development of the central factory system in Demerara, the *Louisiana Planter* is quite under a misapprehension as to the true position of things. Although the canes are practically invariably grown by the same owner in the factory, the estates as they now stand, so far as the cultivation is concerned, consist of amalgamated units which were once separate estates with separate factories. In a sense, then, the present estates are constituted on centralization. There are no planters who "have only small acres of land in cultivation," unless the few villagers who in some instances grow canes on a very small scale and sell them to the neighbouring estates can be called so. Cultivation demands immigration, with hospital and other expenses connected with it, as well as a system of drainage necessitating the maintenance of sea dams, drainage outlets and very often drainage engines, and all this renders the existence of small estates economically impossible.

Careless Statistics.

For an example of the careless reproduction of foreign statistics, commend us to some figures that appeared recently in a London trade weekly, which generally has some columns devoted to sugar. These figures were, it is true, only reproduced from a financial paper, so that the error was not in the first instance our contemporary's; but the latter, professing as it does to know something about sugar matters, might have taken the trouble to edit the reproduction. The figures related to the sugar industry of Argentina and informed the readers that the area devoted to sugar cane cultivation in that country was 70 million odd hectares or, say, 175 million acres. Stupendous! When we consider that the area devoted to beet sugar culture in progressive Germany is only the miserable plot of 450,000 hectares, and the area of the entire island of Cuba, the largest sugar producer in the world, is only 28,160,000 acres. Even if we allowed the very moderate return of 1 ton of sugar to the acre, there would result a quantity of sugar that would need an export trade to some other planet to work the glut off. As, however, we are told finally that the 1910 crop is put at 115,000 tons, we must assume that the statistician woke up before the end of his tale.

But that reminds us that there is a most unfortunate lack of uniformity amongst the principal countries of the world as to the way of expressing the decimal point, *i.e.*, of indicating fractions. We doubt whether many men could say offhand how the Frenchman or the German or the Dutchman punctuates his figures, and one is

generally left to deduce the meaning from other factors. Some express it by a full stop, *i.e.*, a point on the line, others by a comma, in spite of the fact that a comma also generally represents thousands and millions, while we in the United Kingdom go in for what is certainly the most distinctive and least confusing expression, viz., a point about midway over the line. Our foreign readers must admit that the figures "10·45" more certainly stand for $10\frac{45}{100}$ than does "10.45" or "10,45." We are surprised, therefore, that in the interests of scientific intercommunication some international agreement has not yet been arrived at, to establish a uniform system of punctuation of numerical symbols, so that the risk of error shall be eliminated. In the meanwhile the best thing is to have the differences on record, so if our readers in foreign countries would kindly write and inform us what the custom is in their lands, we might draw up a list that, we doubt not, would be of some practical utility for future reference.

Beet Seed Production in Russia.

The Russians, like other peoples, always anxious to become independent of foreign supplies, have been giving great attention lately to the question of beetroot seed which hitherto they have been buying largely from abroad. In order to become, so to speak, masters in their own house, they held a Congress early in 1910 to consider this question, and the committee which was chosen to go further into the views expressed by the Congress states now that special climatic conditions are required for producing the high-class seed they desire, and at all events such climate is not to be found in the southern and south-western districts. It speaks of acquiring seed and acclimatizing it in Russia, so that the same may be used in the southern areas, but for the purpose of carrying out the scheme suggested, and to become entirely independent of foreigners for the seed, an initial expenditure of 2,500,000 roubles (£265,625) is stated as a necessary.

One form that the new movement is likely to take is that projected by Sr. S. I. Brodsky, namely, to constitute a company of seed producers on a co-operative basis with a capital of 300,000 roubles. A much more ambitious scheme, however, is also on the tapis: which is to form an ordinary commercial company with 2,000,000 roubles capital, which shall undertake the work of providing beet seed on, of course, a much larger scale than could be done with a capital of 300,000 roubles. Hitherto the select seed has been brought in from abroad and reproduced in Russia, and it is believed by the promoters of these two projected enterprises, that if either of them is systematically handled Russia may become not only a producer of all the seed she may require, but also of sufficient to develop an export trade.

It is probable that one, if not both, of these projects will assume definite shape; because, at all events, in agriculture, Russia is making giant strides towards comprehensiveness and efficiency, and she is likely to do all she can to make her very important sugar industry Russian from start to finish.

The Sugar Production in Java, 1910.

According to figures given in the *Archief voor de Suikerindustrie in Ned. Indie* the following were the details of the 1909-10 season in Java: 182 factories were at work during the period; of these 161 sent in data to the Manufacturers' Association. They produced 1,150,127 tons of sugar as compared with 1,123,822 tons in 1908-9. Since the total production of sugar in Java in 1909 was 1,241,726 tons, then, assuming the factories unaccounted for do not increase their output, the 1910 total is estimated at 1,278,420, an increase of 2·9 per cent. The sowings in 1910 amounted to 314,335 acres; those for 1911 are expected to cover 325,130 acres, an increase of 3·4 per cent.

Australia's Sugar Crop, 1910.

The Australian sugar production has beaten all records in 1910. The Queensland cane sugar industry has crushed 1,818,781 tons of cane and produced therefrom 207,340 tons of sugar. The actual acreage harvested was 99,634. This compares well with 1909, when 1,163,569 tons of cane were reaped from 80,091 acres and yielded 134,584 tons of sugar. This great increase is accountable partly to the fact that an unusually large area of stand-over cane was left from 1909 and partly to an abundance of timely rain and the absence of frosts. In addition to this, the New South Wales crop may reach 17,000 tons, in which case the total Australian production for 1910 would be over 224,000 tons, or practically equal to the consumption. In 1909 100,000 tons were imported from Fiji, Java, and Mauritius, to meet the demands of the consumption; but in future Australia will probably be self-supporting, if she does not actually go further and start exporting her surplus production.

The Earl of Denbigh, speaking at a meeting of farmers at King's Lynn recently, said he had brought to the notice of the King the efforts that were being made to raise sugar beet in this country. Sir Arthur Bigge had sent him a letter saying that His Majesty took a great interest in agriculture, and trusted that the cultivation of sugar beet might prove to be a very profitable industry to East Anglian farmers.

HOME GROWN SUGAR.

V.

In four chapters I endeavoured to counteract the mischievous effect of erroneous or exaggerated statements flung about in every direction by enthusiasts who ventured to take up a subject they did not understand; and also to correct those who, with similar want of knowledge, threw cold water on every reasonable suggestion.

The question was asked, and has not yet been answered,—why should half, or more than half, of the world's visible consumption of sugar be supplied from the beetroot fields of a small portion of the Continent of Europe, while this country, which is the largest consumer, does not even attempt to produce an ounce? We are told by our statesmen that such a small affair is not worth consideration, and by our agricultural mentors, that we have not got enough sunshine, or that we cannot reap the crop (in October) because we shall be so busy with carrying our wheat (in August). Coming down to common sense, practical men tell us they can get a profit of £6 an acre from mangels and therefore they do not care for a problematical profit of £3 an acre from growing sugar beet. Going back to the region of dreams, another complains that sugar beet would take away too much goodness from the soil, not knowing that sugar, the only part of the root which is not returned to the soil, is created entirely from the water of the soil and the carbonic acid of the air. Lastly, we have a man of science, who tells us quite seriously that he has gone into the question very carefully, so far as he can from foreign figures, with regard to the production, and he thinks it is conclusively shown that they cannot produce beet sugar without a loss of £2 per ton of sugar. At the time when he made that statement they were producing in Europe more than half the sugar consumed in the world, good factories were paying dividends of 20 to 30 per cent., the farmers were getting 21s. per ton for their roots, the price of sugar was at the low figure of 10s. per cwt., and the sugar bounties had been abolished more than five years.

On the other side of the picture we found enthusiasts who wanted to start factories without knowledge, declaring that farmers could get 15, 20, 25 tons of sugar beet per acre, and that factories could get 17 per cent. of sugar out of the roots. It was no use to tell them that even in Germany the average yield of roots per acre is under 12 tons, and that the average yield of sugar from the roots ranges from 14 to 16 per cent. They did not want facts.

Now we are beginning to get a little real daylight to illuminate the shadowy proceedings of the last twelve months. *The Standard* had already taken up the subject in a serious way, and so had *The Times*, but more real knowledge was still wanting. Then came a brighter

gleam of hope. A competent Dutch Company of successful beetroot sugar producers turned their attention to our Eastern Counties and declared their intention to erect a large factory at Maldon. This would have given a real and reliable start to a home grown sugar industry. Unfortunately the project has been abandoned. The farmers did not respond with sufficient energy. Our Dutch friends tried to stimulate them by offering to buy their roots for shipment to Holland if they would grow some experimental crops. The crops were grown, but from all accounts they were not well grown. And then, worst of all, when the roots were delivered the farmers found to their horror that they were to be paid on the weight of clean, not dirty, roots. This put the finishing touch to the enterprise, and it is to be feared that farmers in that part of Essex will not be keen to grow another crop of sugar beet.

The year 1910 has been a remarkably good year for sugar beet throughout Europe, and especially in Russia. Moist growing weather in the spring and summer was followed by a fine sunny autumn, and the crop has turned out to be a record one. The high price of sugar a year ago led to very full sowings, and therefore the production of sugar, instead of being the normal 6,500,000 tons, is giving 8,000,000 tons. This has caused a heavy fall in price, and that may have had some influence in preventing our Dutch friends from pushing on with their proposed factory. The bears forced prices down below 9s. per cwt.; but they have burned their fingers, prices began to recover, they rushed to cover their sales, and now the the price of 88 per cent. raw beetroot sugar, f.o.b. Hamburg, is close upon 10s. If that price were to hold we might perhaps hear again of the Maldon sugar factory, or of another on some more suitable soil in our Eastern Counties.

On the 13th of February *The Times* gave, in more than two columns of large print, an admirable *résumé* of the situation. The writer has evidently taken some trouble to understand his subject, and therefore the article is well worth the careful consideration of all those who take an intelligent interest in the question—even including His Majesty's Government.

The writer bears out the statement made above, that the crops grown in East Anglia for the Dutch market were badly grown, the ground insufficently prepared, the seed sown too late, the weeds not kept under, and so on. The crop was, on the average, a bad one, and the roots were much too dirty when delivered. This was very unfortunate and led to great disappointment. As to cost of growing, the writer is quite right in pointing out that the cost ought not to be debited entirely to the beetroot crop, because there is no doubt that the high farming necessary for the crop has an enormous effect in improving the crops that follow. This is a point that requires further elucidation. As to the cost of production of sugar in the factory, it must not be forgotten,

as the writer very properly points out, that the German factories have, for a long series of years, been writing off large sums and thus reducing their capital account. "It need hardly be added" he goes on "that, if the first English factory is to have a fair chance, great foresight, the utmost economy, *and the largest possible command of Continental experience* are imperative."

He emphasizes this further on, when urging that hard-headed, honest business men, with agricultural interests, should make themselves masters of the subject, and then, if their business experience leads them to be impressed by their calculations, secure the very best technical advice and form a thoroughly sound company. This is good wholesome counsel, and apparently much needed.

Then comes the question, what can the Government do for the new industry? It is all very well for them to assert that "they will have nothing to do with the old and exploded policy of dry nursing an infant industry." This is merely begging the question. It is still worse to talk about "those great industries which depend upon cheap sugar." This is clap trap. The duty on pure sugar is 1s. 10d. per cwt. Does anyone (except a party man) dare to make himself ridiculous by asserting that such a petty sum makes all the difference between cheap sugar and dear sugar. It is a repetition of the old story of the 1s. per quarter on wheat, which made no difference in the price of bread and yet had to be taken off because it furnished material for the party cry about the starving millions who required cheap bread to keep them alive. The science of Political Economy is being dragged in the mud by such language as this. The writer sums up his answer to the question as follows: "For the Government to do nothing means, of course, merely to intimate to those concerned a decision to refrain from taking steps to impose an excise duty on sugar, and at the same time to leave the present import duty alone."

Leaving the burning question of the present demand for a home sugar industry, let us cast our minds back to the year 1837. In the leading article of the *Journal des Fabricants de Sucre* of the 1st of this month, M. Georges Dureau, the Editor, gives us an interesting little story. Turning over, the other day, some old papers, he came upon the *Bulletin des Sucres*, of 1837, where he noticed the review of an essay which had appeared about that time in Germany over the signature of a Mr. Neumann, and in which the writer had drawn a parallel between the manufacture of sugar in Europe from indigenous plants and that carried on in tropical countries. He stated his opinion to be that the tropical competition should be no obstacle to the development of the beetroot sugar industry. He thought that many years or even centuries might elapse before distant tropical countries would emerge from their primitive methods and increase their production. It was a stationary industry, which in fact produced no

more sugar per unit of land than was produced in Europe. The writer then went on to say:—

"Only the English, in these latter days, have introduced into their colonies the use of steam. And yet it is only England, of all the nations of Europe, that takes no interest in the production o' home-grown sugar. A question was put in that country one day to the Minister of the Interior as to what he would do if home-grown sugar were to make as much progress in England as it does in France. 'I would at once take steps,' he replied, 'to tear up the English crop to the very last root; for with us it is impossible to conceive of such a chimerical wealth as would arise from producing two things which would destroy each other.'"

It appears that in the following year, 1838, the *Bulletin des Sucres* gave the following piece of information:—

"The manufacture of beetroot sugar begins to make great progress in various agricultural districts in Europe. Even in England, in spite of the high price of cattle food and of labour, they were about to introduce the cultivation on a large scale, but the colonial interests prevailed against them."

M. Dureau remarks on this that though the British Government would not now "tear up every root from the ground," they observe a neutral attitude and simply refuse to encourage the home industry of sugar production by any preferential treatment. "According to the expression used by Lord Carrington in reply to Lord Denbigh, the British Government have no intention to return to the ancient policy of bringing up new born industries on the bottle. But, adds M. Dureau, failing 'the bottle' it is probable that England will find herself deprived for a long time of those many benefits of which the beetroot sugar industry is always the fruitful source."

This is an interesting little story from old times, and M. Dureau points the moral well.

George Martineau.

The New York Sugar Trade Laboratory has had another successful year during 1910; indeed, the accommodation has had to be enlarged to deal with the expansion of business.

There are to-day in Louisiana some fifty central factories capable of grinding 50,000 tons or more in a season of 60 days or less. In fact at least a dozen of them could tackle 100,000 tons of cane. In addition to these fifty, there are a considerable number that can grind 30,000 to 40,000 tons.

THE BEET SUGAR SITUATION IN ENGLAND.

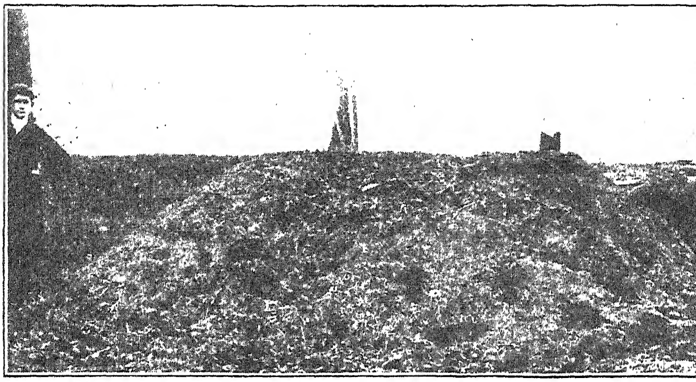
A long and interesting article appeared in *The Times* recently from a very well informed correspondent, dealing with the proposals for a beet sugar industry in this country, and discussing the reasons that have led to the at least temporary abandonment of current projects. These reasons are so pertinent, that we need not apologise to our readers for reproducing them here at some length in the course of a summary of the whole article.

The Times correspondent very aptly prefaced his remarks by a reminder of our great indebtedness to the foreigners for our sugar, four-fifths of it being beet sugar and coming from the Continent. We cordially agree with him when he declares that " public attention should be directed from time to time to such a state of things."

He then discusses the *possibility*. "Can a sugar industry be profitably established here?" He points out that there is all the difference between cultivating a few acres of experimental plot, and carrying out a test on commercial areas under ordinary agricultural conditions. This last test has indeed been made in the case of the beet grown in East Anglia for Dutch firms, but it only served to concentrate attention on the difficulties that seem inseparable from a new venture. As one instance only, the farmers failed to realize that the roots were to be paid for on *washed* weights, and the amount of soil some of them proposed to market with their beets, (in spite of warnings set in their contracts) rose to an exceeding high percentage (as the accompanying illustration will show).

"When however all is said that may be said as to the obstacles . . . . there remain the facts:—(1) That there is an increasing demand for sugar; (2) that while cane sugar may be said to have cheap labour at its back, beet sugar commands disciplined labour and has the advantage of possessing on the spot the best scientific knowledge and the market; (3) that, whatever the cash returns of the farmer may or may not be from beet, Continental and American experience shows that the indirect value of the crop is considerable not only in forwarding succeeding crops manurially, but in inducing deep cultivation; (4) that there is a sociological argument of some weight for the new crop and industry; (5) that the Germans, who by now must surely be beginning to exhaust the advantages derived from the abolished bounties, who have no advantage from import duties which the other signatories to the Brussels Convention cannot command, and spend more on the production of beet, and often on coal, for their sugar factories than is generally supposed, seem to find it profitable to continue to devote themselves to beet . . . . . Against the new industry is (1) agricultural inexperience and indisposition to learn;

(2) a demand, from the only agricultural districts that have experience of beet-growing on a commercial basis, that a higher price shall be paid per ton for beets than has been offered hitherto on behalf of any proposed factory; (3) the present price of sugar, which is below what experts in the past have declared the level ought to be for an industry to have a chance of success." Otherwise expressed, over-confidence on one hand and agricultural indifference on the other are two of the principal adverse factors which endanger the new enterprise.



A Pile of Dirt sent to Holland from East Anglia attached to Roots, and subsequently shipped back to Essex.

Touching on the question of State help, the writer deemed that something might be said for some of the plans offered "if only they did not run counter to the Sugar Convention, to the determination of the Development Commission not to make grants to companies trading for profit, or to the political faith of those who are not the less desirous of seeing sugar factories tried here because they are not adherents of Preference and have a Government of their own way of thinking in power . . . . A typical proposal, which is as impressive as any at first sight, is that the Development Commission should find the money for building and equipping a factory in the form of a State Beet Sugar Experiment Station, and should then lease it to a company, which should work it with a restriction as to *maximum* dividends. There seem to be at least three difficulties in the way of such a scheme." The Board of Agriculture, we are told, is not unsympathetic. "The difficulty of Whitehall-place is to know how to help forward a beet-sugar industry in a business-like way and without running up against the Convention. Obviously, practical suggestions should come, not from the authorities but from the believers in beet sugar, and nothing that has a perfectly workable look seems to have been brought forward

yet. The activities of a public-spirited National Beet Sugar Council (with no funds worth mentioning, needless to say) are all very well, ... (but) what is wanted is that a few honest, hard-headed business men, with agricultural interests, who have plumbed the depths of their ignorance as to sugar manufacture, should get together and carefully examine the figures which have been produced bearing on the prospects of factories, and then if their business experience leads them to be impressed by these calculations, to take the very best technical advice and arrange the preliminaries for the formation of a thoroughly sound company. It should not be necessary to assure the public that there is no room for parent companies nor for company promoting expenditure; the capital of an experimental company must be raised' as it must be expended, on the soundest lines."

In the meanwhile, are we to assume the Government will follow the congenial course of doing nothing? In the opinion of *The Times* correspondent all proposals for State grants "seem to offend the spirit if not the letter of the Convention. It is unnecessary to discuss the pros and cons of that Convention in order to feel that it would be disastrous to throw open once more a question which is almost as complicated and unsettling as that of Schleswig-Holstein." Apart from the Convention, it may be argued in support of the proposal to refrain from taking steps to impose an excise on sugar while at the same time maintaining the present import duty (1) That the sugar industry would be almost in a category by itself; (2) that in the case of the experimental factories it is necessary to start level in every respect with Continental factories or not to start at all; (3) that the first factories must buy experience from which their successors must profit; (4) that altogether this seems to be one of the exceptional cases expressly provided for in the scriptures of Mill; and (5) that if the sugar industry is going to be as advantageous to the country as it is contended that it will be, and if the sharp experience of the past year and the influence of the authorities could somehow ensure that factory proposals should come up to a high standard of financial, commercial, agricultural, and technical efficiency, some sacrifice of strict fiscal principle might be made."

Experiments carried out in Porto Rico as to the most advisable distance at which to space the cane rows and cuttings showed that 5 ft. × 5 ft. was the best arrangement.

Attempts are being made in Cuba, according to Havana papers, to get President Gomez to erect at the cost of the State a model sugar mill to serve as a training school for Cuba's youth. The cost would run to 12 million dollars.

THE SUGAR BEET.*

Its Mode of Cultivation and Development.

By Ed. Koppeschaar.

(Continued from page 73.)

V.

Manufacture.

The object for which the sugar beet is grown, viz., the production of sugar, involves a complicated manufacturing process. In order to accomplish this with profit to the manufacturer, the beets must fulfil certain conditions.

Before entering into details of this important stage of the industry, we will first consider the various ways the grower, and the buyer—the fabricant—may stand in relation to one another.

First, to name the oldest form, there is the so-called *tel-quel* contract, meaning simply one fixed standard price being accorded per ton, the grower getting for so many tons of beet so many times that standard price.

Secondly, we may have a standard price set forth per ton of beets averaging, for example, 15 per cent. of sugar; for any per cent. above or below, the grower receives proportionally more or less than the standard price.

Thirdly, the last-mentioned method of contracting is still further extended in such a way that the grower also participates in the financial gain the factory makes; the per cent. of sugar in the beet is combined in a sliding scale with the price obtained for the sugar. For example, suppose the price paid for beets with 16 per cent. of sugar is 17s. 6d., while the average price at which the sugar was sold is 18s. 4d., then for beets containing 18 per cent., the price of sugar remaining the same, 20s. 10d. will be paid; for beets with 18 per cent., price of sugar being 20s. 10d., 22s. 8½d. will be paid. Moreover, in the particular case of this kind of contract we have in view, the growers get a portion of the net gain, in proportion to the amount of sugar delivered.

Fourthly, the grower may be at the same time part owner of the sugar factory or a shareholder in a co-operative sugar concern.

The importance of the manner in which the farmer's obligations are laid down by contract with the buyer has already been pointed out in the seed chapter. At the time the fabricants received a premium from their respective governments which was based on sugar extracted from beets, it was clear that the *tel-quel* contract must have

been comparable to a tug of war. After the Brussels Convention things of course changed, and we can only look on the survival of this obsolete form of contract as a sample of weakness on the farmer's part. Sometimes (when the choice is left to the farmer) when a wheat sowing has proved a failure, and the farmer introduces beet seed in a hurry, with the chance that the beets will lack those factors needed to ensure rich beets, he will choose the *tel-quel* contract, which discourages endeavours to make the most of it, but on the other hand enables him to secure a fixed price. It should be stated however that years ago, when beet analysis methods were not yet so exact and reliable as they are nowadays, this form of contract was somewhat justified.

The second system will of course give better guarantees that the farmer does his utmost in the way of soil preparation, manuring, hoeing, &c., to ensure his own profit. In choosing the seed there of course remains a difficulty, as a high percentage beet with a small yield per acre might make him a loser in the bargain. As this, however, might cause him to stop growing beets, it is to the interest of the factory that he gets seed that combines good percentage with a fair yield.

The third method, not much met with, might be called an intermediate stage between the second and fourth. Its origin is no doubt to be attributed to the desire of the factory managers thus to encourage the farmers to grow beets for them and to stick to their task. Where a sugar factory's existence depended so greatly on the growing of good raw material, it is conceivable that big privileges were accorded to parties who were not asked to give a quid pro quo in return, save for the growing of beets for one season. Comparing the prices paid for Contract 1 and Contract 3, and seeing the amounts paid out as net participation in profits in 1908-9, amounting to 2s. per 1000 kg., it is hard to understand why this form of contract is not generally preferred by the farmers.

It is evident that it offers as equal a guarantee as does the co-operative system; also that the farmer will try to deliver as good raw material to the factory as he is possibly able to grow, where the interests of grower and buyer coincide.

Here we are brought to the ultimate object of this chapter, the connection between the qualities of the raw material and the very complicated system of manufacture that is needed in order to change the raw material into finished sugar, be it raw or granulated. Though it does not lie within the scope of these articles to enter on a discussion of the technical question relating to beet sugar manufacturing nor of the chemical side of it, we will nevertheless draw up a diagram of what must happen with the beets in a raw sugar factory and also in a white granulated factory:—

Harvesting the Beets. Transport to Factory. Unloading. Piling up. Entering Factory. Washing, Weighing and Slicing.

Slicings.

Sugar extraction.

By-product : Adhering Dirt.

By-product : Pulp.

Raw Juice.

Heated.

Quicklime added.

Limestone, heated with Coke.

Quicklime. Carbonic Acid.

Limed Juice.

Carbonic acid added.

Saturated Limed Juice.

Filtration.

By-product : Limecake.

Clean Juice, lime milk added :

Carbonic Acid added : boiled : filtered :

By-product : Limecake.

Clean juice partly condensed : thick juice : sulphitated : filtered : brought to crystallization : centrifugalled

Raw Sugar : First Product.

First Syrup.

Condensed.

Brought to Crystallization.

Centrifugalled.

Raw Sugar. Second Product.

Second Syrup or Molasses.

Diluted, inverted and fermented.

Alcohol. Potash, Salts, &c.

In the case of the *granulated* process which we give here for completeness' sake, we can take up the raw sugar scheme at the point where our beets are converted into thick juice, the preceding being entirely the same (except that the raw juice receives the quicklime mostly in the form of limemilk, the lime being slaked in the water

that has been used to sweeten off the limecakes, and often the thin, clean juice is sulphitated before being condensed). In its simplest form it is given below :—

Thick Juice : Sulphitated : Filtered.
Mixed juice brought to crystallization.
Centrifugalled.

Crystals with adhering syrup. — First syrup.

Crystals with adhering syrup: Dashed with water containing some ultramarine.

- White granulated. → Dried. → Ready for consumption.
- Wash syrup returned to thick juice *supra*.

First syrup:

- Brown sugar dissolved and returned to thick juice *supra*.
- Second syrup brought to crystallization.
  - Brown sugar dissolved and returned to thick juice *supra*.
  - Third syrup or molasses.

These processes lead up to the ultimate purpose for which we grow our beets:—sugar; the various patent processes, including those which manufacture a highly valued cattle food from the beets besides making sugar as well, are not touched upon.

Neither are the complicated molasses *procèdés* (osmose, strontian, Steffen) as those *procèdés* have nothing to do with our chapter; and, besides, their application is purely a question of calculation*, as to whether they will pay best or not.

Reviewing our diagrammatic schemes we find first of all the harvesting. Remembering that the campaign for a modern sugar factory lasts only 80 to 90 days, we can easily understand that the bringing to the factory of each farmer's share of the crop must be allotted a place in this period of time. It is the factory manager's duty to run the plant at its utmost capacity, thus utilizing the installation fully, while saving coal, wages, and material. He must not be without beets for half a minute; on the other hand, he must not keep too large a store of roots. The beet, as long as it is in an unfrozen condition, is a conglomerate of living cells (see *First Chapter*), which will remain alive and keep on breathing as long as

* In general we would say if a fair price for the sugar contained in molasses can be obtained, the sale of molasses to distilleries deserves attention. The molasses processes all involve extra cost, fuel, and loss of sugar. As to cattle food, it may be said that molasses may be turned into cattle food with profit to a limited extent.

ventilation enables them to get rid of the product of that breathing, carbonic acid. It is evident therefore that the piles of living beets will deteriorate in sugar content, as the breathing process goes on at the expense of the stored up sugar. To reduce this loss to a minimum is the duty of the factory, as the beets are paid for on the basis of sugar content on arrival at the factory. Another drawback of too big beet piles is that the inner beets get too warm from lack of ventilation, and then will rot and get soft, giving trouble in the slicing machine and the battery.

Having shown the farmer already the importance of the chöice of seed in regard to late or early harvest, it will be his interest to leave the beets in the field until they have fully ripened. The limit to this will, of course, be the risk of frost; when the ground is frozen it is impossible to dig out the roots. If the farmer has harvested his beets, and yet cannot ship them immediately to the factory, he has to pile them up, in not too large open, even piles, which will protect

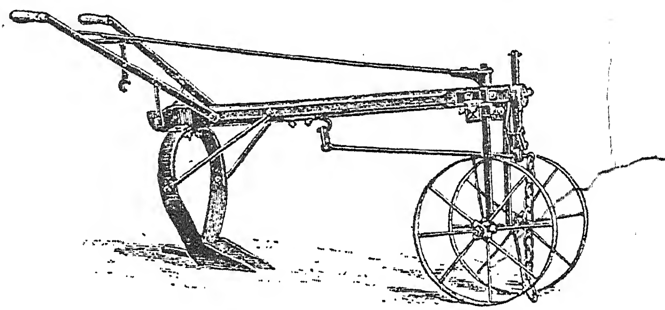


Fig. 1.

them against light frosts. Care should be taken not to wound the beets with sharp-pronged forks, as these wounds offer easy inroads to the spores of fungi (see *Fig. 1, I.S.J.*, Nov., 1910). The digging out of the roots is either done by hand with the aid of a special fork, or with the beet puller (see *Fig. 1*). After the adhering dirt is shaken off, the leaves with head are separated from the root. The top of the beet does not contain as much sugar as the rest, but it contains more salts, which hinder the crystallization process later on. On the other hand it will make a fairly good cattle food when ensilaged, or will serve occasionally as green manure, when ploughed well under together with the beet leaves. (When insect pests are feared it is wiser to ensilage them). If we divide our beets into conical sections, they will contain approximately the relative percentages shown in the accompanying sketch (*Fig. 2*). The tail ends, containing 8 per cent. and forming 0·8 per cent. of the weight of beet, are worked up separately in some factories; they also contain more salts than the body.

Besides the higher saline content in the heads, which tends to hinder the crystallization and the forming of molasses, we should also mention the nitrogen content which is highest in the heads. Though no longer of the same importance as it was formerly,* the nitrogen content of the beet is still of some importance to the fabricant. The albumen nitrogen is attacked by the lime added, and escapes partly in the form of ammonia in the carbonatation pans, and is partly retained by the lime cake. The ammonia nitrogen is liberated in the juice while being condensed, and is drawn off in part through the ammonia tubes of the evaporators, and in part finds its way into the condensation water from the evaporating pans.

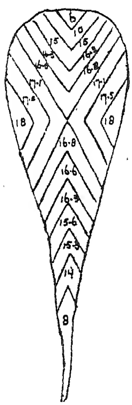


Fig. 2.

A third part, however, escapes the heating and the lime, and tends to form molasses, the final by-product, a sugary solution from which any ordinary means cannot induce the sugar contained in it (about 50 per cent.) to crystallize out. The so-called *harmful nitrogen*, in combination with the sugar content, should gauge the value from an industrial standpoint.

Looking up our diagram anew, we find in the washing and slicing stages points to draw attention to. The beets should be freed from the adhering dirt as thoroughly as possible in the field; it is clear that beets showing an unfavourable shape (as sketched on page 612 of the December issue of this Journal) will have more dirt sticking to them and will be hard to clean. This dirt, deposited after the washing process into large basins, forms a constantly occurring item of expense as the basins must be emptied at intervals. Besides, it costs money to transport the dirt to the factory, and it often causes trouble when a test, taken by the samplers, reveals a very high percentage of dirt, for the factory has to take this so-called tare into account.

When the beets are washed clean, they are then cut up into thin slices by the aid of revolving knives. As on the quality of these slices depends for the largest part the good working of the extraction apparatus, the battery, it is evident that soft, rotten, woody beets, stones, pieces of iron, &c., are the enemies of good regular extraction.

The extraction in the battery, taking the form of diffusion, is accomplished by the aid of water under a pressure of about $1\frac{3}{4}$ atmospheres. Good sound slices can stand this pressure, but soft ones, with no more *elasticity* in their cells, cannot; and the writer has seen a battery for this reason come to a complete stand-still, in which case

* The application of stable manure and nitrogen fertilizers used to be forbidden or restricted in old-time contracts, but nowadays no restrictive clauses are inserted in beet contracts.

some tons of slices have to be sacrificed before the work can be re-started. On the other hand, woody beets, from the shooters already described, will cause the knives to choke; they prove a regular nuisance, inasmuch as the knives must be changed continually. The presence of stones (some will always escape the stone-catchers provided for them) involves the destruction of beet knives (a knife costs 1s. 6d.), to say nothing of the delay caused in stopping the mill, and the bad cuttings caused by broken knives.

The necessary crystallization processes call for a raw material with but little salt content. Selection has done its part already in this direction; 30 years ago the beets showed about 3·84 per cent. ash in the dry substance, at present it is about 2 per cent. Still as, *e.g.*, in the case of choice of potash fertilizer, the grower can influence this salt percentage. Frozen beets, though not a raw material to be favourably looked upon, can be worked up, but frozen beets that have thawed out and are soft and rotten will cause trouble all through the course of manufacture.

(To be continued.)

AERIAL ROPEWAYS FOR SUGAR TRANSPORT.

Aerial ropeways, first introduced some thirty years ago, are now a well-known means of transport, but so far they have not been applied to any great extent to the carriage of sugar, Hawaii, Mauritius, and Queensland, being about the only places that have recognized their utility for transporting finished sugar from high lands adjacent the sea down to the loading berth at the water level, and in the opposite direction for raising stores to the sugar mills. As there must be many other localities where similar conditions rule, and a ropeway could be profitably installed, we offer our readers a few notes on the construction and working of this system, which have been supplied by Messrs. Bullivants' Aerial Ropeways, Ltd., Mark Lane, London.

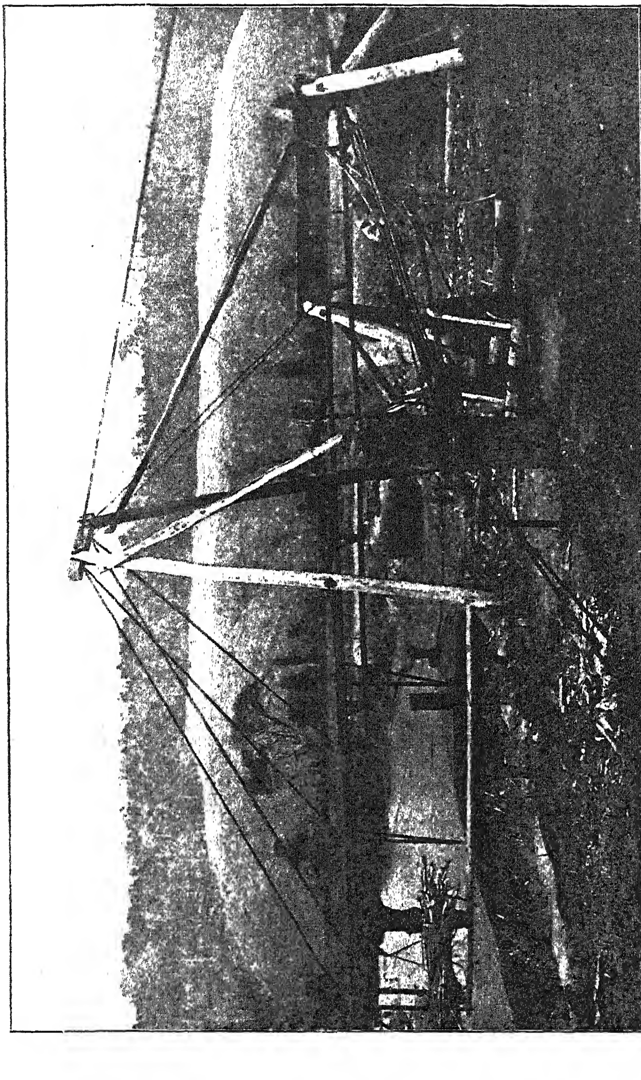
There are several arrangements devised by this firm, but the one best suited for sugar estates where the gradient is not too steep and there is no traffic in the opposite direction, is that which comprises the use of one fixed rope placed on an incline, on which carriers, from which are suspended loads, are allowed to run down uncontrolled one at a time. This is generally called a "shoot." This system is of a simple nature, and used for the transport of undamageable goods. It consists of a light wire rope stretched between two points, the elevation of one being considerably above that of the other. On this, loads from 1 cwt. to 2 cwt., hanging from a runner carrying one or two wheels, are allowed to run down uncontrolled. At the lower end,

WIRE SHOOT.—Supplied by BULLIVANT & Co., Ltd., and erected by the Engineer in charge on the site.
LOADING STATION: 2-cwt. bundles of Sugar Cane being lifted on to Ropeway.

brushwood, or other convenient means, is provided to absorb the force produced by the running load when it arrives at the lower terminal. This can be considerably lessened by regulating the sag of the rope where the section of ground will admit, so as to reduce the speed of the runner with its load as it approaches the lower terminal. Spans can be made without support up to 7000 feet, and all that is required for fixing the rope is a good anchorage at the upper end, and another with a tightening gear at the lower end. Ropes for this purpose up to 3500 feet spans are used, made in the form of a strand; above this, in order to obtain the necessary strength with a moderate size of wire, ropes are used consisting of several strands formed each of several wires. The runners have wheels of small diameter, and are made as light as possible, in order that after 50 or 100 loads have been delivered, the empty ones may be carried up to the upper end for a further delivery of material. Where, however, the gradient is steep and other goods have to be transported upwards, a more suitable system would be one in which carriers hanging from a fixed rope are drawn along returning on a parallel rope.

The following description of the ropeways as used in Mauritius is after Wallis-Tayler:—

"The arrangement consists of a driving gear at one end, or terminal of the line fitted with a driving drum suitably geared to receive rotary motion, which, in this instance, is provided by the power of the cane mill, and a similar wheel at the other end fitted with tightening gear, an endless band of wire rope being mounted on these wheels. At intervals of about 200 feet intermediately between these terminals the rope is supported on pulleys mounted on posts at a suitable height to enable the carriers to clear all intervening obstacles, and to a certain extent also to regulate the general level of the line. The carriers hang from the rope and are enabled to pass the supporting pulleys by means of curved hangers. These curved hangers are pivoted on V-shaped saddles resting on the rope, the saddles having malleable cast-iron frames fitted with friction blocks to enable the requisite friction on the rope to be obtained, and allow the carriers to pass with the rope up steep inclines and over the pulleys, wings at each end of the saddle frames embracing and passing over the pulley rims. The saddle frames are besides each fitted with two small wheels mounted on pins which admit of the carrier being removed from the rope at the terminals, and at curves, on to shunt rails held in such a position that when the carrier approaches the terminal the small wheels will engage on it, and running up a slight incline lift the friction clip saddle from the rope and enable it to pass to the loading or unloading station or round the curve wheels, the impetus derived from the speed of the rope being sufficient for the purpose of enabling the carriers to free themselves automatically from the rope."



DISCHARGING STATION.

Operator releasing load from Shunt Rail to Cane Punt below.

Respecting the lasting power of the ropes, which are the chief wearing parts and the most expensive to renew, it may be of interest to state that on a line in Spain constructed on this system, carrying 300 to 350 tons per day over a length of one mile, the rope carried over 160,000 tons. This represents an outlay of about $\frac{1}{4}$d. per ton per mile for rope renewal.

Including renewals of wear and tear and labour, but not fuel, the average cost per ton per mile for transport, may be taken as varying from $\frac{3}{4}$d. to 2d.

The cost of the materials for constructing such a ropeway varies (assuming that the supporting trestles are made of steel) from £1000 to £1700 per mile, according to length, gradient, and load to be carried. The motive power may be steam or water which ever is most easily adaptable.

THE ST. KITTS CENTRAL SUGAR FACTORY.

We have lately learnt that a company has been formed in London for the erection of a central sugar factory in the island of St. Kitts, that the debentures and shares have been fully subscribed, and that preparations are being made to put the construction of the works in hand at once.

We think that the same is likely to prove a very remunerative investment to the subscribers, as it has been placed on the market by the well-known firm of Messrs. Henckel, Du Buisson & Co., who about six years ago brought out and have since successfully worked a similar company in Antigua, on lines which will be followed by the new undertaking in St. Kitts. We therefore propose to give a description of the past working of the Antigua Company, which will we think prove to be of some interest to our readers, if only for the reason that it affords a very striking example of the advantages to be gained by co-operation between cane growers and sugar manufacturers pure and simple, which will probably result in a substantial benefit to owners of sugar properties in the West Indies, especially to the smaller planters who have in past years been very heavily handicapped by the necessity of finding capital, not merely for the growth of cane but for the manufacture of sugar on their own estates.

It stands to reason that with their limited resources it was a matter of considerable difficulty not merely to turn out cane of the best quality but also to produce sugar of sufficiently high saccharine value fit to compete in the open market with countries like Java, Cuba, and Mauritius, which grow cane on a much larger scale and possess mills containing the best modern machinery, managed by first rate chemists and engineers. By the system practised in other localities, and now successfully initiated in Antigua, the planter is released from the

task of manufacture and is able to devote the whole of his capital and time to the production and improvement of his crop (improvements which become necessary by the requirements of the central factory), while the process of manufacture of the finished article is transferred to a central mill, managed by professional engineers and chemists.

It is in the experience of the writer that not many years ago owners of West Indian estates were unable to put in a crop without the assistance of advances from merchants, who naturally objected to risk their money unless secured by a mortgage of the crops; but by the co-operation of the planters and the manufacturers there ought to be a much more favourable outlook for the estate owners both great and small.

The principle on which the Antigua Company was formed and managed had for its base the mutual co-operation of planter and mill-owner, and was carried out in the following manner:—In the first place the planters entered into an agreement with the factory to grow and deliver for a term of fifteen years cane sufficient to supply the factory, the capital for the erection and working of which being obtained partly by a loan of £15,000, free of interest, from the Government of the Leeward Islands and partly by the issue of shares and debentures to the amount of £25,000 by a company formed for the purpose of building a central factory.

Each debenture (of the nominal value of £100 and redeemable by means of a sinking fund, which would retire them all in a fixed term) carried with it an allotment of 50 "A" shares of 1s. each, and was issued at £97 10s. 0d., which with the 50 "A" shares made up the sum of £100. There was also a provision for the issue of "B" shares at 1s. each to the planters. The following table contains a summary of the six years' working:—

Year.	Tons.	Price. £ s. d.	Debenture Interest. £	Shareholders' Profit. £	Sinking Fund. £	Reserve. £
1	1634	12 15 5	1250	1942	2000	1000
2	2348	8 4 8	1250	Nil	2000	..
3	4230	9 16 0	1250	3172	2000	1000
4	4695	11 15 9	1238	7081	2000	1000
5	3995	10 7 5	999	4133	2000	..
6	5390	12 16 8	931	7231	2000	3000
	22,292		£6918	£23,559	£12,000	£6000

Here, year 1 shows a return of 1634 tons of sugar at £12 15s. 5d. per ton, out of which after paying expenses there remained for dividend £1942, for interest £1250, for sinking fund £2000, and for reserve £1000. Year 2 is a bad year, yielding only enough to pay expenses, interest, and sinking fund. Year 3 good return, low prices but good dividend. Year 4 good return, high prices and large profit.

Year 5 return and prices lower, profit fairly good, but no addition to reserve. Year 6 best returns, prices and dividends plus £3000 to reserve. It should be noted also that in years 5 and 6 the debenture interest has fallen from £1250 to £931, pointing to a large redemption of debentures and a considerable appreciation of "A" shares, also to a return of profits, divided and undivided, of £23 7s. 0d. per share, a return both creditable to the management and encouraging to the new enterprise at St. Kitts.

Turning now to the new company which will be run on the same lines, we observe that it will not receive any assistance from the local authorities as in the case of Antigua, the experience derived from the latter showing pretty clearly that the business is in itself quite capable with good management of doing at least as well as its predecessor and needs no extraneous assistance, especially as the factory will be constructed on a larger scale, and apparently will draw its supplies of cane from an extensive district of a proverbially fertile island.

We hear also that it is intended to construct a light railway to facilitate the delivery of a plentiful and regular supply of cane; and on this subject we may be allowed to suggest that the building of such a railway or tramroad would involve considerable expense for permanent way (particularly if the sidings be carried up to the cane pieces), not to mention that a fair proportion of the outlay would be required for rolling stock and consequent items (*e.g.*, in imported coal, always an expensive article in the tropics), that it might be better to employ motors (using oil fuel, and drawing the planter's carts, at all events in the first instance) which will be able to run right up to the headlands of the cane fields, and we cannot help thinking that some considerable economy may be effected by adopting some such expedient.

We would also suggest to the planters who will be relieved from the burden of manufacturing their sugar that the employment of agricultural machinery (also using oil fuel) and the adoption of intensive cultivation would be very advisable. These are times of severe competition, and it behoves them to make use of the best and most modern methods if they wish to turn out a first rate article, the raw material of which is certainly within the ability of one of the most productive spots in the Lesser Antilles to supply.

In conclusion we hope that the co-operative system begun by Antigua and followed by St. Kitts will take a firm hold in the British West Indies. We honestly believe that there is a good time coming for the smaller tropical colonies which the present movement, combined with cotton planting, lime and rubber growing, and other industries, will do much to realise.

THE HAWAIIAN SUGAR PLANTERS' ASSOCIATION ANNUAL MEETING, 1910.

Reports to hand from Hawaii show that the Sugar Planters' Association had another successful annual meeting last November.

The outgoing President stated that they had just completed the third decade of combined co-operation of the sugar planters of the Hawaiian Islands. After discussing the working of the local land laws he went on to refer to the immigration experiments. He said the introduction of Russian immigrants from Manchuria by the Board of Immigration during the past year had not come up to expectations, and further attempts to obtain immigrants from that source had been abandoned for the present. It was regrettable, in his opinion, that this influx of an entirely new class of most promising labourers—and in time very likely a desirable addition to the population—ceased through dissatisfaction brought about by immigrant agitators who did not first acquaint themselves with the true conditions of surroundings entirely foreign to them. Subsequent investigations, made by the Federal Government, had shown that these immigrants had no cause for dissatisfaction as to the conditions under which they had been induced by the Board of Immigration to come to Hawaii. An agent of the Board of Immigration had started a few months previously for the Azores and Madeira to further recruit Portuguese immigrants. The latter, as evidenced by the experience of many years, had proved by far the most desirable element, being of a thrifty and industrious nationality, and for some time past had contributed largely to the industrial welfare as well as civic development of the islands. The President therefore hoped the mission would be successful. He added that the gaps caused by labourers leaving the country had been filled, more or less, during the past year with Filipinos, and it was highly gratifying to state that they had proved quite satisfactory as field-labourers. For the time being at least, the association depended on this immigration to some extent to keep up its labour supply.

A number of features inaugurated during the past year at the recommendation of the Board of Trustees had been conducive to a better feeling among the plantation labourers; for instance, they had extended the cultivation contract system as much as feasible on every plantation, under which arrangement greater opportunities had been given the labourers to augment their earnings; they had also paid a bonus, which innovation had been in many instances an incentive among the day labourers for steadier work.

The President then referred to the work of the Experiment Station and said it had been as hitherto highly efficient; he specially mentioned the successful introduction of cane borer parasites. Sufficient time had not, it was true, elapsed to determine whether that parasite

would establish itself under local conditions, but the indications were encouraging. To Dr. Perkins and Mr. Muir great credit was due; to the former as being the one who conceived the plan on the lines so successfully adopted for subduing the leaf hopper, and to Mr. Muir who, at a risk to his health, spent four years abroad hunting for the parasite, and then devised an elaborate arrangement for transferring it successfully to Hawaii.

When the Experiment Station report came on for discussion, it was stated that the experiment work would require more room but the Station being now in the heart of a residential locality, it would probably pay well to sell the whole place and erect a larger station in a more open district nearer the plantations. The Experiment Station Committee had the matter under consideration.

Reports on the following subjects amongst others were read to the meetings: "The Manufacture of Sugar and Utilization of By-Products" by J. N. S. Williams, "Cultivation and Fertilization on Unirrigated Plantations" by J. A. Scott, "Labour-Saving Devices" by J. T. Moir, "Burning before Cutting," "Cutting, Loading, and Transportation," and "Sugar Manufacturing Machinery." No details of these papers appear at present to be available but it is to be hoped that they will be published sooner or later, so that other cane sugar countries may have the benefit of them.

BRITISH GUIANA.

Work in the Experimental Cane Fields during 1910.

The Report issued by Messrs. Harrison & Stockdale of the work done in the Experimental Cane Fields of the British Guiana Board of Agriculture, during 1910, appeared in a recent number of the official journal.

We learn that this year some Bourbon canes were grown on lands which had not been occupied by sugar cane since the Botanic Gardens were established. Their yields were accordingly treated as standard yields with which to compare the yields of other varieties. A comparison of the three best varieties with the standard is shown by the following table:—

Variety.	Parent.	Class.	Tons cane per acre.	Per cent. of canes.	Juice. Sp. Gr.	Lbs. per gallon.	Sucrose Tons per acre.
118	D625	Plants	53·7	65·5	1·076	1·844	6·03
625	Dyer	Ratoons	45·9	69·7	1·072	1·668	4·98
419	D625	,,	32·9	67·0	1·079	1·889	3·85
Bourbon	—	Plants	24·8	68·9	1·071	1 667	2·66

There were over a dozen other instances of superiority; on the other hand quite a number of varieties gave returns which compared unfavourably with those of the Standard Bourbon.

The above three varieties also topped the list when grown with what may be deemed the normal nitrogenous manuring in British Guiana, viz., with 300 lbs. sulphate of ammonia per acre, their tonnage both of canes and of sucrose in juice being slightly higher than in the above table.

The most interesting features of the year are the large field yield and the high sugar contents of the juice of 118, a seedling of D 625, and the markedly higher average yields of the latter cane where planted on somewhat the poorer land in rows 5 ft. apart than where planted on better land in rows 6 ft. apart, the closer planting having resulted in an excess yield of 7½ more tons of canes with ·89 tons of indicated sucrose in their expressed juice.

A new series of plots were laid down for the further investigation of this problem. As in other years with plant canes, the differences between Bourbon canes grown after Bourbon canes and Bourbon canes grown after other varieties were not very marked. The following are the results obtained in this series :—

	Tons of Cane per acre.
Bourbon after Bourbon	18·6
Bourbon after D 2468	19·9
Bourbon on the same land as the above but which had not previously been under canes	24·8

These results point to the alleged deterioration of the Bourbon cane being possibly due more to induced defects in the soil than to the degeneration of the variety.

With very few exceptions, the beneficial effects of manuring with nitrogen were clearly apparent with all the varieties under trial. The tests showed the following means in tons per acre: No nitrogen, 22·0; normal nitrogen (300lbs. sulphate to the acre), 30·6; high nitrogen (450lbs), 32·7.

Comparative trials were also conducted as to the comparative value of various sources of nitrogen; sulphate of ammonia, nitrate of soda, nitrate of lime, nitrolim and dried blood were all tried, but the first-mentioned proved best. As, however, these trials were for the 12 months only, and the wet weather may have influenced some of the results, they cannot be said to be conclusive.

But the report considers that the unfavourable results obtained in 1909-10 with nitrates, both where applied in single dressings and in repeated applications, should give pause to planters contemplating the substitution of nitrates for sulphate of ammonia in the manuring of their cane fields. Over a quarter of a century's experience in comparative trials with nitrate of soda and with sulphate of ammonia has shown that in normal years manurings of about 2 cwt. of sulphate of ammonia and of 2½ cwt. of nitrate of soda give very similar increases, that where heavier applications are made the action of nitrate of soda is uncertain and usually less favourable than that of

sulphate of ammonia, and that in years of excessive or even heavy rainfall the beneficial effects of nitrate of soda, even in light applications, may fall far below those of sulphate of ammonia. Another important point to be borne in mind when considering the advisability of the substitution of nitrate of soda for sulphate of ammonia is the very unfavourable effect of the former on the tilth of heavy clay soils. Repeated heavy dressings of nitrate of soda may so injure the condition of heavy clay soils for sugar cane cultivation that years may elapse before they return to their normal conditions of productiveness for that crop. This may not, and probably will not, result from repeated applications of nitrate of lime, but reliable data are not yet available.

For some years past data have been accumulating pointing to a possible injurious action of any excess of soluble salts in the manures applied to cane cultivation on heavy clay soils. In connection with this the following mean results of trials of sulphate of ammonia without and with sulphate of potash and superphosphate of lime may be of interest:—

TONS OF CANE PER ACRE.

	No. Nitrogen.	Sulphate of Ammonia. 200 lbs. Yields.	Increase by Nitrogen.	400 lbs. Yields.	Increase by Nitrogen.
Without Potash and Sulphates	14·7	20·2	5·5	26·8	12·1
With Potash and Sulphates	16·2	18·7	2·5	28·4	12·2

TONS OF CANE PER ACRE.

	Sulphate of Ammonia. 500 lbs. Yields.	Increase by Nitrogen.
Without Potash and Sulphates.. ..	31·7	17·0
With Potash and Sulphates	31·2	15·0

Little, if any, advantage has on the whole been gained by the addition of the sulphate of potash and superphosphate of lime to the manurings with sulphate of ammonia. The fact that with dressings of sulphate of ammonia in the relatively low proportion of 200 lbs. per acre, the yields with sulphate of ammonia alone have been higher than with potash and phosphates in addition to it is significant.

A large number of manurial trials with and without superphosphate of lime were made, but what increases there were, due to the addition of superphosphates, were clearly not remunerative.

The effects of some heavy dressings of lime applied in 1891, which were very marked for many years after, are now exhausted. They were thus apparent for 17 years covering 14 crops.

THE DETERMINATION OF SUCROSE (CANE SUGAR) IN SUGAR FACTORY PRODUCTS BY CLERGET'S PROCESS, USING INVERTASE AS HYDROLYST.*

By James P. Ogilvie.

INTRODUCTION.

In determining the percentage of sucrose in sugar factory products by the Clerget process it has been recognised for some time past that other bodies than sucrose (and raffinose, if present), such as the "gums," vegetable acids, and certain nitrogenous compounds and decomposition products, may be affected by the action of the concentrated acid, and that the actual value which the determination is intended to express may thus to a more or less extent be vitiated. For this reason several well-known investigators have proposed to replace the use of acid by that of the invertase enzyme of yeast, as a hydrolyst capable of acting *selectively* upon the sucrose in the presence of impurities of the nature indicated.

PREVIOUS WORK.

Although Kjeldahl (*Res. Compt. rend., Lab. Carlsberg*, 1881, *1*, 192), and later C. O'Sullivan and Tompson (*J. Chem. Soc. Trans.*, 1891, *59*, 46), conclusively demonstrated that accurate results were obtainable by the use of invertase as the hydrolytic agent, the highest percentage of sucrose estimated in this way was about 10 per cent. in a so-called "treacle."† Heron had pointed out (*Thorpe's Dictionary of Applied Chemistry*, vol. iii., p. 656) that in the Clerget process "instead of carrying out the inversion of cane sugar by acid O'Sullivan and Tompson's yeast process may be employed;" but it was left to Ling and Baker (*J. Soc. Chem. Ind.*, 1898, *17*, 111) to indicate the possible value of inversion with invertase in the analysis of molasses and other low products of the sugar factory. Working with both cane and beet molasses, these authors showed that the figures for Clerget by invertase differed appreciably from those found in the ordinary way, and they contended that this fact was *a priori* to be accounted for by defects in connection with acid hydrolysis. Hudson (*U. S. Dept. Agric., Bur. Chem., Circ.* 50; and this *Jl.*, 1910, *12*, 192) quite recently used a specially prepared solution of invertase for the examination of a variety of sugar products, estimating the invert sugar by the copper reduction method as well as polarimetrically, and the conclusion drawn by this investigator, so far as cane syrup and bagasse are concerned, was that "the invertase method of hydrolysis gives percentages which agree with those obtained by acid hydrolysis," a conclusion contrary to that arrived at by Ling and Baker.

*Paper read before the Society of Chemical Industry (London Section) on 2nd January, 1911; and published in the Journal of the Society, 1911, *30*, 62-64.

† A diluted syrup, which called for no special treatment in defecation.

METHODS OF DEFECATION.

In now taking up this line of investigation,* which is one of considerable importance to the sugar factory chemist, the present author found that the principal difficulty to be contended against when operating with invertase on very dark molasses was that of suitable clarification, It is well-known that enzymes are extremely sensitive towards acids and alkalis, and it was soon observed that the action of invertase is entirely prohibited by the presence of a reagent like basic lead acetate. To act upon the undefecated molasses with invertase and afterwards clarify with basic lead acetate, certainly does not yield accurate results, owing to precipitation of levulose and dextrose, although such results may be of some comparative value; whilst to use the solution defecated with basic lead acetate for the direct polarization, and then to eliminate the lead in solution by means of sodium carbonate, potassium oxalate, &c., likewise introduces an error, owing either to precipitation of the reducing sugars, or to the influence of these reagents or the product of their reaction with the lead salt, on the rotatory power of the sucrose. After a number of preliminary experiments, the method of clarification chosen, as being free from sources of error, was to defecate with basic lead acetate, to eliminate this reagent as lead sulphite by sulphur dioxide (in the way first proposed by Pellet for the ordinary Clerget process), and then to neutralize the excess of acidity, a procedure which has been found to work well, being easily carried out, and giving constant and satisfactory results.

DEFECATION FOR THE INVERTASE INVERSION.

As finally modified, this method for the clarification of molasses solutions for invertase inversion stands as follows: Four times the normal sugar-weight of the sample are transferred to a standardized 200 c.c. flask, defecated with the minimnm amount of basic lead acetate solution (Sp. gr., 1·26), a little alumina cream added, then the liquid adjusted to bulk at standard temperature, well shaken, and filtered. 100 c.c. of the filtrate are measured by a standard pipette into a small beaker, sulphur dioxide passes in from a syphon of the liquified gas till a faint smell is perceptible (all the lead thus being indicated to be precipitated), then the liquid transferred to a 200 c.c. flask, made up to the mark, and well mixed. Now sufficient calcium carbonate (dried) in fine powder to neutralize the excess of acidity, and a little recently ignited kieselguhr, are added, after which filtra-

* This work was suggested by M. Pellet's recent interesting article in the *International Sugar Journal*, 1910, 306, in which it was observed that it would be of value to carry out some experiments on sugar products, such as juices, syrups, and molasses, so as to definitely ascertain whether the invertase method yields results at all different from those obtained by the ordinary hydrochloric acid method. M. Pellet also said (*loc. cit.*):—"The invertase method requires much more time than does the hydrochloric acid method, and we fail to see the advantage of substituting a tedious and delicate process for a rapid and well-known one, the results of which leave nothing to be desired when due care is taken in its accomplishment."

tion follows.* In this way a normal solution is obtained, which is sufficiently clarified to give a distinct polarimetric reading, is free from lead and excess of acidity, and is therefore well suited for the invertase inversion.

INVERTASE INVERSION.

The method employed for the invertase inversion was essentially that devised by O'Sullivan and Tompson (*loc. cit.*), the exact procedure being as follows: 50 c.c. of the molasses solution, prepared in the manner just described, contained in a 100 c.c. flask, are raised in a constant temperature bath to 50-55° C., after which 0·5 grm. of washed brewery yeast†, and 2 drops of acetic acid, are added, and the temperature maintained as near 55° C. as possible for 4½ to 5 hours. At the end of this time the liquid is cooled, a little alumina cream or kieselguhr added to assist filtration, and made up to bulk at standard temperature. The clear filtrate is then polarized in a lateral-branched water-jacketed tube at exactly 20·0° C., this temperature being determined by a thermometer reading to 0·1° C.

ACID INVERSION.

The ordinary acid inversion was carried out exactly in the manner prescribed by Herzfeld, the precautions indicated by Pellet (*Ann. Chim. anal.*, 1909, *14*, 243; and this *Jl.*, *abs.*, 1910, *12*, 96) for the avoidance of possible errors being carefully observed. It may be mentioned here that all polarimetric readings, both direct and inversion, were made at 20·0°C., the necessity of making a temperature correction thus being obviated. The acid inversions in some of the determinations were rendered uncertain on account of the dark colour developed by the action of the acid during inversion, and it was then found neccessary to decolorize with a small quantity of animal charcoal. The material used was prepared from a finely ground refinery char of high decolorizing power by boiling with hydrochloric acid, washing until free from acid, and then well drying. Extracted charcoal cannot be used for decolorizing for the direct reading, since it then adsorbs sucrose; but it may be used for decolorizing for the inversion reading, provided that it is not in excess, and that the liquid is acid, facts have been pointed out by Pellet, Beaudet, and other chemists (*Bull. Asoc. Chim. Sucr. et Dist.*, 1891, *9*, 439-624), and are now confirmed by the author.

CONSTANTS.

When carrying out Clerget determinations a frequent source of error is the selection of an incorrect constant for the calculation of the sucrose

*Lead sulphite is a very troublesome precipitate to filter. Pellet advises the addition of paper pulp; whilst Watts and Tempany (*J. Soc. Chem. Ind.*, 1908, *27*, 55), who have also used the sulphurous acid process, advocate the addition of kaolin in small amount; but the present author, using a special close filter paper and a little kieselguhr, found that a bright filtrate was obtainable almost at once.

†Obtained from a well-known London brewery, *i.e.*, English top fermentation yeast.

value. Herzfeld (*Zeitsch. Ver. deut. Zuckerind.*, *40*, 194) has drawn up a table of constants by means of which account may be taken of the change in the rotatory power of the levulose with varying dilution, and his values have been confirmed by Ling (*J. Soc. Chem. Ind.*, 1898, *17*, 110); but as Pellet has pointed out from time to time it is very advisable in accurate work for the chemist to re-determine the constant to be applied, for the purpose of checking the individual method of operating (the standardization of flasks, pipettes, &c.), as well as with the object of verifying the dextro- and levo-rotatory graduation of the polarimetric scale of the instrument employed. Since in the present research only beet molasses polarizing 48- 54°V. was used, the procedure adopted in establishing the constants was to take 50 c.c. of a ½-normal sugar-weight solution of the purest refined sugar* (carefully dried), to invert with invertase and acid, to dilute to 100 c.c., and to polarize at 20·0°C. The results obtained, as the mean of several determinations, were 131·6 for the invertase inversion, and 132·0 for the hydrochloric acid inversion. It may be stated that in some of these determinations the procedure followed was exactly parallel to that used in analysing the molasses, *i.e.*, to the pure sugar solution basic lead acetate solution was added (half the amount used for the molasses), and this eleminated in the manner described above, after which the invertase and acid inversions were carried out. The figures thus obtained corroborated those found with pure sugar solutions to which lead solution had not been added, thus showing that the sulphur dioxide treatment causes no inversion of the sucrose whatever, and thus generally establishing the accuracy of the process.

Experiments with Beet Molasses.

On then carefully carrying out a series of determinations with beet molasses, comparing the invertase method with the ordinary Herzfeld modification of the Clerget process, some interesting results were obtained. The generally accepted assumption is that the more powerful acid hydrolyst should yield the higher results. Quite contrary, however, to this expectation it was found that the invertase method gave distinctly higher results, and this invariably so in each of the samples of beet molasses examined. Blank experiments showed conclusively that these higher results were not caused by the formation of optically active bodies from the yeast during the period of inversion at 55° C., or by the influence of the small amount of solid matter introduced with the yeast or the alumina used for clarification.

Explanation of the Higher Invertase Results.

While considering the reason of these higher results given by the invertase method, the author's attention was drawn to the valuable work of Ehrlich, Andrlik and Stanek, Pellet and others upon the optically active non-sugars of the sugar beet. Briefly summarized,

* Containing, water, 0·030; and ash. 0·025 per cent., after drying.

the investigations of these well-known chemists show that the rotation of the optically active amino-acids in very low beet products varies considerably according to whether the reaction be alkaline, neutral, or acid, so that in the ordinary Clerget determination a source of error exists in taking the direct reading in an alkaline solution (due to basic lead acetate) and the inversion reading in an acid solution (due to the hydrochloric acid used to effect inversion). Andrlik and Stanek (*Zeitsch. Zuckerind. Böhm.*, 1906, *31*, 417) demonstrated that a 1·0 per cent. solution of glutamic acid indicates the following polarizations in Ventzke degrees according to the reaction of the solution:—Alkaline (15 c.c. of basic lead acetate in 100 c.c), —1·45; neutral, —0·35; and acid (5 c.c. in 100 c.c.), + 1·77; whilst in the case of aspartic acid the figures are for the same concentration, + 12·25, —1·00, and + 1·40 respectively. With an osmose water the direct readings taken in alkaline, neutral, and acid solutions were 14·75, 14·85, and 15·80; and with a molasses, 22·4, 22·5, and 23·2 respectively. As the result of these observations, Andrlik and Stanek (*loc. cit.*) concluded that "the optical determination of sucrose in syrups, molasses, and osmose waters, in presence of optically active amino-acids cannot yield accurate results, *and therefore the Clerget process as ordinarily carried out is untrustworthy*."

THE ANDRLIK POLARIZATION.

Andrlik and Stanek, however, devised a modification of the ordinary Clerget process for the purpose of obviating the influence of these optically active bodies, which simply consisted in taking the direct polarimetric reading, not in an alkaline (to basic lead acetate) medium, but in a solution containing the same amount of acid as that used for the inversion reading, betaïne or urea* being added to inhibit the inversion of the sucrose during the time of reading. On applying this method to the analysis of osmose waters and molasses they found that values are thus obtainable that are higher than those given by the ordinary Clerget procedure (in which the direct reading is taken in the alkaline solution defecated by basic lead acetate) by 0·9 to 3·2 per cent.; and it was concluded by Andrlik and Stanek that *this method involving the direct polarization in an acid solution gives the truest sucrose values.*

ALKALINE, NEUTRAL, AND ACID POLARIZATIONS.

The next step was to apply these considerations to the problem under investigation. In so doing, determinations were made of the alkaline or basic lead acetate, the neutral, and the acid direct polarizations, by working in the following manner: 5 times the normal sugar weight of the molasses were weighed out, washed into a 250 c.c.

* Many other substances in addition to betaïne or urea retard the rapidity of the hydrolysis of sucrose by acids, as *e.g.*, neutral organic salts, alcohol, and acetone. For further information reference should be made to Prof. von Lippmann's "Chemie der Zuckerarten."

flask with a little warm water, cooled, defecated with the minimum amount of basic lead acetate (50 to 60 c.c. of a solution of sp. gr. 1·26), a little alumina cream added, then the solution made up to bulk at standard temperature, and filtered. For the direct alkaline polarization, 25 c.c. were diluted with water to 50 c.c., being adjusted to bulk at the temperature at which flask and pipette were standardized, then read at 20·0°C. 100 c.c. of the double normal weight solution were next treated with sulphurous acid as previously described, made up to 200 c.c., excess of calcium carbonate* and a little kieselguhr added, then filtered. By reading this liquid the *neutral direct polarization* was obtained. For the *Andrlik or acid direct polarization*, 25 c.c. of the neutral solution were placed in a 50 c.c. flask (using the same pipette and flask as before), made up to about 49·5 c.c. with a solution containing 10 c.c. of concentrated hydrochloric acid (of the same density as the acid used in effecting the Herzfeld acid inversions) and 10 grms. of pure urea in 100 c.c., then adjusted to bulk at standard temperature with water, mixed, and quickly read in the water-jacketed tube at 20·0°C. From experiments with pure sugar solutions the author is satisfied that the urea does not modify the polarization of the sucrose, neither does the polarization change and inversion occur until after the lapse of 7 to 10 minutes. After this the invertase and acid inversions were carried out, using this neutral solution, and following the procedures already indicated.

RESULTS OBTAINED.

The Clerget values then obtained, summarized in the following table, are very interesting:—

SAMPLE.	1.	2.	3.	4.
Direct alkaline (basic lead acetate) polarization	48·8	—	48·6	47·0
Direct neutral polarization	49·2	52·0	49·0	47·6
Direct acid (Andrlik) polarization	50·4	53·25	50·0	48·4
Direct acid (Pellet) polarization	50·3	53·3	—	48·3
Invertase inversion polarization	—14·6	—16·0	—15·0	—14·4
Acid inversion polarization	—13·2	—14·6	—13·6	—13·8
Clerget value by invertase	48·5	51·7	48·6	47·1
Clerget value by acid, using alkaline direct polarization	47·0	—	47·1	46·1
Clerget value by acid, using neutral direct polarization	47·3	50·4	47·4	46·5
Clerget value by acid, using acid (Andrlik) direct polarization	48·2	51·4	48·2	47·1
Clerget value by acid, using acid (Pellet) direct polarization	48·1	51·4	—	47·0

On comparing these results, it is seen that the invertase method gives values that are higher than the ordinary Herzfeld method (as

* On adding calcium carbonate to neutralize the slight excess of sulphurous acid some calcium bisulphite, which is soluble, is formed, but the amount is quite inconsiderable, and the solution after treatment with calcium carbonate is to all intents and purposes neutral.

used by Ling and Baker, and by Hudson) by 1 to 1·5 per cent., differences that are much beyond the permissible limit of error attendant on the process; * but it is also seen that the invertase method gives results which approximate very closely with those obtained by acid inversion if the influence of the optically active non-sugars be obviated by using the Andrlik porlarization. Assuming that by the use of the Andrlik polarization the results given indicate the true sucrose value, or at any rate the truest hitherto obtainable, an hypothesis that is probably quite valid, then the fact would appear to be established that *invertase is a selective hydrolyst, i.e.*, that it inverts only the sucrose without affecting the non-sugar bodies present, either by hydrolyzing them, or by modifying their rotatory power. It is needless to point out that such a hydrolyst would be of the greatest value in investigating the problem of obtaining correct results in the case of complex and impure sugar factory products, like osmose waters and waste molasses, whether the optical (Clerget) or gravimetric (copper test) methods be used. For practical purposes, the author's procedure, as it stands at present, is perhaps too lengthy and involved. There is, however, a method due to Pellet which not only eliminates the error caused by the non-sugars, but is also comparatively simple, and has other very apparent values.

PELLET'S SULPHUROUS ACID PROCESS.

In a letter to the author, M. Pellet describes this method as follows: Make up 200 c.c. of a normal sugar weight solution of the molasses, add to it 10-15 c.c. of basic lead acetate solution, complete the volume to exactly 220 c.c., mix well, and filter. Take 100 c.c. of the filtrate, add to it 10-15 c.c. of a saturated solution of sulphurous acid and some paper pulp, make up to 200 c.c., mix, filter, and polarize at 20° C. in the 400 mm. tube, using the necessary correction for the dilution. This gives the *direct polarization.* Take 50 c.c. of the solution, and invert either according to the original Clerget routine, or the Herzfeld modification, and read at 20° C. This gives the *inversion polarization.*†

Now the most important advantage of this process from the point of view of the present investigation is that the direct polarization of the solution acidified by sulphurous acid gives the same figure as the Andrlik polarization, in which concentrated hydrochloric acid is used, and that the error due to the optically active non-sugars is thereby eliminated. That, at any rate, is what the author has proved in the case of the samples of beet molasses under examination, as the following comparative readings show:—

* Since the same solution was used for both acid and invertase inversions only one direct reading was necessary, and the error of observation was consequently diminished. The author's experimental error should therefore be less than 0·5 per cent., the permissable limit of error between two independent workers.

† Full details of this method are given in *Bull. Assoc. Chim. Sucr. et Dist.*, 1891, *9*, 439 and 624, together with some interesting results.

Sample of molasses.		Andrlik acid polarization.		Pellet acid polarization.
1	....	50·40	....	50·30
2	....	53·25	....	53·30
4	....	48·40	....	48·30

Other advantages of the Pellet process are:—(1) The liquid is appreciably decolorized for the direct reading, and during inversion the development of colour by the hydrochloric acid is effectually prevented, considerations which are certainly important, especially when dealing with very dark cane molasses, like Cuban or Egyptian. (2) Since the liquid used for inversion is free from lead, the 5 c.c. of acid added to effect hydrolysis is all utilized; none is removed as lead chloride from reaction, thus rendering the inversion quite certain. The latter is indeed quite an important point, for an error is introduced by using more or less acid than the amount employed in establishing the constant, owing to the influence of hydrochloric acid upon the rotatory power of the levulose, a point which has been studied by Tolman (*J. Amer. Chem. Soc.*, 1902, *24*, 515) and several others. (3) Yet another advantage noticed by the author when working with the Pellet process is that inversion by the sulphurous acid does not occur for some time after treatment, for an hour at any rate; whereas in the Andrlik polarization inversion by the hydrochloric acid in the presence of urea sets in after only 7 minutes, so that the observation must be made almost immediately after the addition of the acid.

FUTURE WORK.

Arising out of the present research, the following lines of investigation, which the author hopes to take up if opportunity permits, have suggested themselves:—(1) To extend the results obtained to the examination of beet waste molasses, osmose waters, and of cane molasses. (2) To study the action of invertase on pure solutions of non-sugars, especially glutamine, glutamic acid, asparagine, aspartic acid, the products obtained by the incomplete decomposition of invert sugar by lime, and the products of superheating sucrose, especially the so-called "Bodenbender substance," &c., at a temperature of 55°C. for 5 hours, and thus if possible conclusively establish the fact that invertase has no action on these non-sugars, and is indeed a selective hydrolyst. (3) To compare the results obtained by the optical method with those found by the gravimetric and volumetric methods, using both acid and invertase as hydrolysts. (4) To account for the low yield of alcohol met with in the fermentation of cane molasses when the sucrose is estimated by the ordinary Clerget process.

Considerable help has been received from M. Pellet, the eminent French sugar specialist, in carrying out this investigation, more especially in connection with the consideration of the higher results obtained by means of invertase, and the influence of the optically active non-sugars. There is no greater authority on this complicated

branch of analytical work than M. Pellet, and the author takes this opportunity of thanking him for much valuable advice, so courteously and willingly given.

CONCLUSIONS.

(1) If in determining the sucrose in beet molasses by Clerget's process invertase be used as hydrolyst, distinctly higher results are then obtained than with the ordinary Herzfeld modification in which concentrated hydrochloric acid is used as hydrolyst.

(2) But if in operating the Herzfeld process the error due to the influence of the optically active non-sugar substances be obviated, by using the direct acid polarization, instead of the usual alkaline (basic lead acetate) polarization, then the results do not differ appreciably from those obtained by means of invertase. From this the fact would appear to be established that *invertase is a selective hydrolyst*, inverting only the sucrose (and raffinose also, if present), without at all affecting the non-sugar bodies.

(3) The Pellet method of obviating the error due to the influence of the optically active non-sugars, by taking the direct polarization in a solution acid to sulphurous acid gives the same results as the method proposed by Andrlik and Stanek in which concentrated hydrochloric acid and urea are used, besides having certain other apparent advantages. As a practical method, Pellet's sulphurous process is now recommended as preferable to the Andrlik and Stanek procedure, by reason of its greater ease of manipulation and several other apparent advantages.

MOLASSES AS A FERTILIZER.

By G. N. MARTIN.

Chemist, South African Sugar Refineries, Limited.

In a very interesting article on the "Disposal of Waste Molasses from Hawaiian Sugar Houses" in the January number of this Journal, Mr. Sedgwick states on p. 32 that "its value (the molasses) as a fertilizer or soil renovator has not yet been determined."

I beg to give my own experience with the use of molasses as a fertilizer; and also quote from a report by Mr. Bonâme, Director of the Station Agronomique, Mauritius.

The experiments were carried out in 1897. A level piece of ground of homogeneous character was selected; the field divided into four equal plots; each plot of same length and breadth and equal quantities of cuttings planted.

Plot No. I. was cultivated in the ordinary way, receiving the usual fertilizer as employed on the rest of the estate—nitrogen 50 lbs., phosphoric acid 70 lbs, potash 50 lbs. per acre; made up of the following: sulphate of ammonia, dried blood, superphosphate and sulphate of potash.

Plot No. II. was grown with fertilizer as above, but received in addition molasses at the rate of 600 gallons per acre.

Plot No. III. received a mixture of 400 gallons of molasses, one ton (2000 lbs.) of press cake, and 1000 lbs. of bagasse ash per acre.

Plot No. IV. received nothing.

The following is the tabulated result:—

	Plant Canes. Tons per acre.		Ratoons. Tons per acre.
Plot No. I...	34·1	..	28·3
,, ,, II.	42·5	..	31·6
,, ,, III...	40·2	..	33·8
,, ,, IV.	24·6	..	17·2

My experiments were not on such an elaborate scale as those carried out in 1908 by Mr. Bonâme. Besides doing the usual routine work of the estate, owners are not usually very prone to waste time in carrying out experiments. But up to the time of my leaving the estate in question the use of molasses was continued, and probably still is, with very beneficial results.

The molasses was employed at the rate of 400 to 600 gallons per acre, being simply spread in the furrows, and a week or fortnight after spreading, the planting was done. The quantity of molasses produced on the estate did not allow for the whole acreage to be planted to be so spread. A very marked difference could be observed between fields (sometime contiguous) treated with molasses, and fields cultivated with the usual fertilizer.

Mr. Bonâme's report fully confirms my previous experiments. In case Mr. Sedgwick is not in possession of Mr. Bonâme's report, I give below the results of these experiments:—

Plot No. I.—Manure containing no potash.
,, ,, II.— ,, ,, no phosphorus.
,, ,, III.— ,, ,, no nitrogen.
,, ,, IV.—Complete.
,, ,, V.—No manure.

With Molasses.	I. Kilogs.	II. Kilogs.	III. Kilogs.	IV. Kilogs.	V. Kilogs.	Averages. Kilogs.
Virgin canes ..	45,620	33,600	45,840	46,400	28,320	39,420
1st ratoons	30,960	26,820	28,740	34,080	19,740	28,080
2nd ,, ...	27,540	24,240	20,640	28,380	13,320	22,800
3rd ,, ...	30,300	26,040	22,500	31,260	15,980	25,380
Averages	33,600	27,670	29,430	35,050	19,340	28,920

Without Molasses.	I. Kilogs.	II. Kilogs.	III. Kilogs.	IV. Kilogs.	V. Kilogs.	Averages. Kilogs.
Virgin canes ..	33,960	29,160	34,440	36,360	26,280	31,040
1st ratoons	28,920	25,440	24,780	31,920	18,600	25,920
2nd ,, ...	25,800	21,000	17,700	25,200	14,520	20,820
3rd ,, ...	29,100	29,460	20,160	27,600	16,560	24,600
Averages	29,440	26,260	24,270	30,270	18,990	25,590

Mr. Bonâme further states that "the growth is vigorous, and that it is an excellent way to force a tardy plantation, and that very often it catches up, and sometimes outgrows canes planted a few months previously . . . .

"The effect of molasses is very marked, particularly with plant canes, but seems still to act on the ratoons as well. Its effect is very noticeable on Plot No. I. with no potash and No. III. with no nitrogenous manure. These results fully agree with the composition of molasses, which brings to the soil these elements as we pointed out above, &c., . . ."

In a good many colonies molasses is used as a fertilizer either by spreading on the ground or with irrigation water.

I hope some experimental station will take up the matter and carry on experiments with the use of molasses, employed in various proportions and also diluted with water, so as to determine its exact value as a fertilizer.

A MODEL BEET SUGAR FACTORY.

Bouchon read before the Beet Sugar Manufacturers' Syndicate of France an interesting monograph on a model beet sugar factory. We give a general outline, for the many hints given should be useful to those who contemplate starting a beet sugar factory. The first question proposed was what machines should be used in order to get the best results and how should they be arranged so as to attain that end, the problem in view being to turn out two grades of white sugar and a residuary molasses with a saline quotient of about 4·7. Upon general principles one must not forget that in the manufacture of beet sugar the expensive items are labour and fuel, without counting the cost of the beets; consequently the main problems to solve are those of economizing steam and labour and decreasing the sugar losses. With this idea in view one should centre one's attention upon simple methods. The factory should be well arranged, having a central hall with two side buildings—in the left one the beet washers, the diffusion battery and the drying plant for handling the residuary cossettes should find a place. In the central building should be situated the various machines for handling the juice. There should be an upper central gallery; this enables one to keep under eye the general run of the sugar plant In the building on the right locate the appliances for working the syrup, massecuite, &c., and the sugar warehouse. Here should be placed also the boilers, the multiple effects and vacuum pans. Under these conditions the length of the pipes is reduced to a minimum.

The beets are brought to the factory in well arranged flumes. These give excellent results when ample water can be obtained. In the hydraulic carrier at certain intervals are placed stone separators,

also certain well arranged rakes which retain all the floating stems, leaves, &c., on the surface. These if allowed to remain would ruin the edges of the slicing blades. For the same reason great advantages are to be derived through the use of shakers and brushes, upon which the roots slide before entering the washer. There need be very little said respecting the washer, but it is desirable to collect the residuary products and separate the tip ends of broken beets so that they may be returned to the diffusion battery or sent to the cossette dryers, after which they are combined with molasses for cattle food. In the factory at least two beet slicers are needed. Many of these machines give excellent results, providing the slicing blades are sufficiently sharp and are kept in proper position.

The diffusion battery should have balanced emptying doors. A system based upon a forced circulation, worked by one pump for two batteries, which allows one to draw off a thick hot juice, is very interesting, not only on account of the excellent exhaustion obtained, but also owing to the fact that the capacity of the battery is increased. The Steffen method is to be given an extended practical trial this year in France, data from which will be made known and it will then be possible to realize within what limits the claims are justified.

Continuous diffusion promises well in Bohemia, where it originated. Without doubt in diffusion the closing and opening of valves is fatiguing, and when all this may be handled mechanically a great progress will be realized. As for liming beet juice there is nothing new to reveal; these operations had best be conducted in suitable mixing vats with milk of lime. The carbonatation should be done so that the operation is continuous. This offers no difficulty when the workmen are well trained for the work. It is, however, necessary that some precautionary measure be taken to prevent an excessive deposit of carbonate of lime at the bottom of the appliance. Before reaching the multiple effect there is the sulphuring; liquid sulphurous acid is recommended. The operation should be continuous. The use of liquid anhydrous sulphurous acid, costing more than the sulphurous fumes obtained through sulphur burning, offers many advantages; no sulphur furnaces are needed. Whatever may be the method used, the sulphurous acid obtained always contains traces of sulphuric acid (about 0·13 per cent.). This sulphuric acid has many objectionable features, such as inverting sugar. In most cases the results obtained with anhydrous liquid sulphurous acid are better; there is no need of a circulation pump. When sulphuring with gases from a furnace the sulphur losses may reach 31 per cent., while the loss in the case of liquid anhydrous sulphurous acid is only 0·5 per cent. The operation may be conducted by a boy, the only attention needed being to watch the pressure in the receiver and allow the anhydrous acid to expand before being sent in a gaseous state to the sulphuring apparatus.

As for filtrations, very little progress has been made of recent years. This is due to the fact that the number and kind of filtering substances is very limited. For a long time to come filtering cloths will be in vogue, the lower the pressure within reasonable limits the better the results—to filter rapidly and well are two conditions rather in contradiction. The excessive cost of the filtering cloths, their washing, &c., has led to many successful efforts in sand filtration. Paper pulp appears to have some future as a filtering medium. The filter presses have undergone but few changes, their working is tedious and it is in their vicinity where the greatest difficulties are found as to cleanliness. Of late the forcing by pumping of the dry scum has been an important advance over the hand and car system for their transportation. The pipes and pumps must be strongly made so as to resist a pressure of about 10 kilos. for about 150 meters length of piping. Evaporation is conducted in this model factory in a four compartment effect, with a fore circulator. The vacuum pans are close at hand; preference is given to the suspended tubular compartment, with central tube in which revolves a spiral; this helps the circulation and causes a continual agitation of the mass when the graining is completed. The product falls into suitable cooling mixers, which may be regulated so as to suit each special case, in order to prevent the production of false grain, working against viscosity. Experience shows that spiral hollow mixers give the best results. It is recommended to use suspended centrifugals, with bottom emptying. These may be run either electrically or with a hydraulic motor. Notwithstanding that these have many objectionable features they, on the other hand, offer many important advantages. They seem of late to have come very much into vogue. They are readily kept clean and are in direct action by means of a suitable high pressure centrifugal pump. It is well to remember that when working at high pressure the efficiency may reach 75 per cent. Saillard's experiments have shown that for ten centrifugals, 1050 mm. diameter, with hydraulic motor, there are only four men needed.

There are many advantages claimed for this model factory. All the movements of the juice, syrup and after-products are handled by centrifugal pumps with electrical motors; the action is direct. The general handling is very simple, but it is advisable to have a limited number of pumps held in reserve in case of accident. For the electrical force there are used two turbo-alternators with triphased currents. It is this kind of current which is best suited for the transportation of power, with a small voltage sufficient for moderate distances. The apparatus in its general working may be relied upon and the cost of running is reduced to a minimum. The steam for the sugar factory is furnished by a series of seven tubular boilers, divided into low and high pressure; there are automatic heaters, with automatic fuel feeders. There are also automatic clinker removers.

These automatic devices greatly reduce the work to be accomplished. The limekiln has a turbo-compressing attachment, with continuous suction and forcing combination. These may be worked electrically. All the appliances of the factory are continuous and rotating, no alternating motion existing. The Westinghouse rotating air-pump is one of the best. The boilers are fed by means of a high pressure rotating pump. It is most important that registering devices be placed at as many points possible of the beet sugar manufacturing process, so that the engineer in charge may follow night and day all that is going on. The weight of beets sliced, coal, lime, stone, &c., used are known; also the quantity of sugar actually made. When possible it is desirable to have continuously recorded pressures, temperatures, &c., of the liquids at the various stages of manufacture. The voltage and amperage variations should be known also. A modern beet sugar factory should have a pulp dryer. The time is not far distant when the agricultural feature of the sugar plant will be the main source of profit.—(From the *Sugar Beet.*)

SCALING ON JUICE-HEATERS EMPLOYED IN THE SULPHITATION-DEFECATION PROCESS.*

By J. J. Hazewinkel.

Director of the West Java Sugar Experiment Station.

On several occasions trouble has been experienced by the heavy scaling of the juice-heaters used in the sulphitation-defecation process.

Generally this scaling is ascribed to irregular sulphitation, or to carrying the operation too far, so that the calcium acid sulphite is spontaneously decomposed by heat, and calcium sulphite, which attaches itself firmly to the sides of the tubes, is deposited.

On consideration it, however, seems to me that this theory is not tenable, for investigation showed that limed and well-sulphured raw juice, filtered cold, gave a liquor that formed a precipitate on boiling, in spite of the fact that the cold tempered juice had given a distinct alkaline reaction to phenolphthalein.

It appears that the presence of acid sulphites is not absolutely necessary to cause this precipitate. This is shown by the following simple experiment.

If to an organic lime salt neutral potassium sulphite be added, no effect is observed in the cold. On, however, boiling, a precipitate is directly formed. This happens if, for example, calcium acetate be used.

The reactions taking place in sulphitation must therefore be considered as follows:—

* Specially translated from the Java *Archief* for this *Journal.*

(1) In liming:

potash salt + lime = lime salt + 2 KOH (potash).

(2) In sulphuring:

lime salt + 2 KOH (potash) + SO_2 (sulphurous acid) = lime salt + K_2SO_3 (potassium sulphite) + H_2O (water) + $CaSO_3$ (calcium sulphite).

(3) On warming:

lime salt + K_2SO_3 (potassium sulphite) = $CaSO_3$ (calcium sulphite)* + potash salt.

From this it directly follows that there is a connection between the potash content of the juice and the rapidity with which the juice-heater becomes scaled. Factories working juices rich in potash should therefore experience more difficulty from this source than those having juices with a low potash content. This accounts for the great differences in the amount of scale in juice-heaters of Javan factories.

As a striking illustration of the extent to which scaling may occur, it may be mentioned that at Prambonan a thin layer of fine crystals, 70 per cent. of which consisted of $CaSO_3$, had deposited, and that even the pipe leading from the sulphiters to the pump had repeatedly become stopped.

The reaction—organic lime salt + K_2SO_3 = $CaSO_3$ + organic potash salt—occurs in time, and only on heating is it momentarily completed. Directly after sulphuring, the reaction sets in very slowly without heating, but if rather much potash be present then in a few days a distinct quantity of calcium sulphite will deposit in the sulphiters.

Now most owners of juice-heaters with iron pipes complain of the difficulty of cleaning. In order to investigate whether the material of the juice-heater plays a rôle, an iron and a brass bar were placed in two adjacent tubes in a juice-heater on the Bandjardawa estate. After some time, both had become equally coated; but whereas the film held so loosely on the copper that on drawing the bar out of the tube much was lost, the film in the case of the iron bar was attached very firmly. Hence copper tubes present an important advantage, so far as the cleaning of the juice-heater is concerned.

Theoretically it may be possible to obviate the formation of scale in juice-heaters, but it is questionable whether this is so practically. It must be particularly borne in mind that the limed and sulphited filtered juice on boiling becomes much lighter when the above mentioned precipitate forms. Hence from the chemical point of view the process is satisfactory, although technically it is not so.

* In the laboratory experiments the calcium sulphite formed in this way so strongly adhered to the glass that it could not be removed by simple rinsing.

Correspondence.

METHODS OF CHEMICAL CONTROL.
A CORRECTION.

To the Editor of "The International Sugar Journal."

Sir,—In the "Methods of Chemical Control for Cane Sugar Factories adopted by the Hawaiian Chemists' Association," which you published in the January number of your *Journal*, there were a number of errors copied from the original, as follows:—

p. 19, seventh line from bottom, "100-105°C." should be "125°C."

p. 19, formula near the bottom of page should be

$$f = 100 - \frac{100\ m}{100 - b}$$

p. 21, thirteeenth line from bottom, after "sodium sulphite," insert "making up to 100 c.c."

p. 22, formula near the top should read,

$$\frac{100 \text{ Pol. Bagasse}}{(100 - f) \text{ Pur. R. J.}}$$

p. 22, fourteenth line from top, "W = Weight of bagasse," &c., should be struck out.

There are also two small typographical errors in the copy which were not in the original, and which change the meaning to some extent:—

p. 23, thirteenth line from bottom, after "lead acetate" there should be a comma.

p. 25, twelfth line from top, "+ 99·7" should be "99·7 +."

The Chemists' Association would be obliged to you if you will publish these corrections in some future number of the *Journal*.

Yours truly,

R. S. Norris.

ABSTRACTS, SCIENTIFIC AND TECHNICAL.*

Extraction of Sugar from Dried Sugar Cane. Anon. *La. Planter*, 1911, *46*, 39. Compare also this *Jl.*, 1910, 307, 313, and 634.

The highly interesting and important experiment on the extraction of sugar from dried cane, which is being conducted by the United States Sugar Co., has now been completed. The first attempt to extract the sugar from the desiccated material by means of a diffusion battery was unsuccessful, since a proper circulation could not be effected (*cf.*, this *Jl.*, 1910, 634); but now, it is stated, this difficulty

*These Abstracts are copyright, and must not be reproduced without permission.—(Ed. *I.S.J.*)

has entirely been overcome by the use of centrifugals. On arrival from Cuba, the baled shredded cane was torn up by a set of saws, and passed by a blower to the top of the factory. There it was allowed to fall through a hopper into a vat, in which it was digested with water, then the resulting mush was fed into centrifugals, machined, and washed once. In this way the percentage of sugar in the dried, shredded cane was reduced from 55 or 60 per cent. to about 0·01 per cent. in less than two minutes. Subsequently the spun-out juice was subjected to the double carbonatation process, using in the first tempering 2 to 3 per cent. of lime, in the form of 25 to 30° Bé milk, then sulphured, and finally evaporated and cured in the ordinary way. The sugar thus made was light yellow, but on reboiling and machining a fine white product, which was both hard and of a good lustre, was obtained. From the analytical figures given in the article it appears that the juice spun out from the centrifugals, not including the water used for washing, had a purity of only 72·5 to 74·4 and a density of 11 to 14 Brix, which after carbonatation and sulphuring became 75 to 77·5 purity and 5 to 6·5 Brix. After evaporation the thick-juice had a purity of 76·7 to 77·5 and a density of 60 to 61 Brix, while the figures for the resulting massecuite were 74·5 purity and 92·8 Brix. It is stated that the drying plant at Nipe Bay, Cuba, is being enlarged, and that continuous centrifugals are being installed in place of the ordinary sugar machines at present in use. In this way the capacity of the plant will be increased from 30 tons of dried cane or 90 tons of standing cane, to 100 tons of dried, or 300 tons of standing cane, per day of 24 hours. It is intended to recommence the experiment this month.

Loss of Invert Sugar in the Carbonatation Process (as applied to Cane Juices). *By W. E. Cross. La. Planter, 1911, 46, 55.*

When making white sugar by the carbonatation process, the reducing sugar contained in the juice is decomposed by the lime into organic acids and other compounds to an extent depending upon the temperature, the amount of lime used, and the duration of contact. In the present paper the author, who is research chemist at New Orleans, U.S.A., Sugar Experiment Station, gives an account of experiments on the determination of the rapidity of this decomposition at different temperatures and with varying amounts of lime. Using a solution containing 10 per cent. of sucrose and 1·5 per cent. of reducing sugar, *i.e.*, the proportions found in Louisiana cane, liming was effected with (*a*) 1·8 and (*b*) 1 per cent. of lime at temperatures from 30 to 70° C., and for periods of time ranging from 5 to 60 minutes. The figures obtained, indicating the rate of the decrease in the percentage of reducing sugar, were as follows :—

1·8 Per Cent. of Lime.

Temperature ..	30° C.	40° C.	50° C.	60° C.	70° C.
Original solution..	1·5	1·5	1·5	1·5	1·5
After 5 minutes ..	1·44	1·32	1·3	1·15	0·71
After 10 minutes ..	1·38	1·2	1·13	0·85	0·48
After 15 minutes ..	1·24	1·12	0·9	0·67	0·36
After 20 minutes ..	1·21	1·05	0·84	0·51	0·29
After 30 minutes ..	1·17	0·93	0·63	0·38	0·24
After 45 minutes ..	1·04	0·75	0·42	0·28	0·21
After 60 minutes ..	0·92	0·57	0·30	0·22	0·17

1·0 Per Cent. of Lime.

Temperature ..	30° C.	40° C.	50° C.	60° C.	70° C.
Original solution..	1·5	1·5	1·5	1·5	1·5
After 5 minutes ..	1·48	1·36	1·33	1·1	0·84
After 10 minutes ..	1·42	1·22	1·17	0·94	0·53
After 15 minutes ..	1·41	1·17	0·94	0·96	0·33
After 20 minutes ..	1·4	1·12	0·78*	0·62	0·33
After 30 minutes ..	1·36	1·09	—	0·49	0·24
After 45 minutes ..	—	0·97†	—	0·40	0·18
After 60 minutes ..	1·26	0·72	0·35	0·31	—

It is thus clearly shown that the rate of decomposition increases with both the temperature, the time, and the amount of lime. At the higher temperatures the rate of decomposition is very rapid, most of the reducing sugar being decomposed during the first few minutes. It is of some importance to note that decomposition proceeds steadily even at 30° C., and that for this reason any delay in carbonatating the limed juice means an unnecessary loss of reducing sugar—a loss that lessens the value of the final molasses. If, however, carbonatation is conducted at 40° C., and unnecessary delays are avoided, the loss of reducing sugar is very small. The general conclusion arrived at as the result of this work is that during the carbonatation of cane juices the temperature should not rise above 45° C. If 45° C. be exceeded the decomposition products formed are highly injurious bodies that inhibit crystallization, whereas those resulting at lower temperatures are comparatively harmless in this respect.‡

Some Experiments on Clarification, using the Carbonatation Process. *By W. E. Cross. Modern S. Planter, 1911, 41, 2-6.*

Hitherto it has been found impossible to apply the carbonatation process of making white sugar to Louisiana juices, owing to their high reducing sugar (glucose) content. Browne and Blouin (*Bull.* 91, *La. State University*) found, as the result of numerous investigations on the subject, that even when the temperature was as low as

* After 25 minutes. † After 40 minutes.

‡ *Cf.* also Prinsen Geerligs' "Cane Sugar and its Manufacture," page 174 *et seq.*—(Ed. *I.S.J.*)

30 to 40° C. (and then clarification was incomplete) the reducing sugar was strongly attacked, and substances highly injurious to crystallization were formed. Now, however, the present author, who is research chemist at the New Orleans Sugar Experiment Station, has again taken up the question, and has been successful in elaborating a modification of the carbonatation process practicable under the conditions obtaining in Louisiana. In some preliminary experiments it was found that at temperatures above 52 to 53° C. there was a great loss of reducing sugar, and in consequence a production of the dark-coloured, humic acid products that retard crystallization. On the contrary, below 45° C. the juices were of a good colour and comparatively free from the injurious substances (*cf.* previous Abstract). At this low temperature, however, clarification is incomplete, owing to the fact that some of the precipitate (being insoluble only in alkaline solution) re-dissolves on carbonatating back to neutrality. So as to obviate this, the author was led to try the double carbonatation process, as practiced in the beet sugar industry; and in these experiments the average figures for the increase of purity were: with single carbonatation, 2·36°; with double carbonatation, using 1 per cent. of lime, 4·8°; and with double carbonatation, using 2 per cent. of lime, 6·2°. After this it was endeavoured to decrease the amount of lime employed by using aëration to effect the better coagulation of the precipitate, thus again utilizing the experience of the beet industry, and the results obtained were so promising that it was resolved to carry out experiments on the large scale. In a sugar house run the juice was heated to 40° C., limed with 0·6 per cent. of CaO, aërated for five minutes, and carbonatated to 1·5 c.c. alkalinity; after filtering the carbonatated juice, it was reheated to 40° C., relimed with 0·06 per cent. of CaO, and then carbonatated to neutrality. The increase of purity thus effected was (73·4 to 78·2) 4·8, whilst the decrease in the glucose ratio was (12·7 to 9·9) 2·8. No difficulty was caused by incrustation when evaporating the syrups, and it is stated that a better massecuite was obtained by this method than by the sulphitation process. As a possible disadvantage the cost of limestone and carbonic acid gas is admitted, but it is suggested that the extra cost per ton may prove to be insignificant in comparison with the greater profit resulting from the better class sugar produced. An extended series of sugar house trials is necessary to prove this point, and this work the author intends to take up in the coming season.

EXPERIMENTS ON BAGASSE DRYING. *By E. W. Kerr.* *Modern S. Planter*, 1911, *41*, 13. Compare Pellet, this *Jl.*, 1907, 339.

The important problem of utilizing the heat passing up the factory chimney for drying the bagasse used for the furnaces, and of thus obtaining a greater fuel value, has recently been studied by the author

with special reference to the conditions of sugar manufacture prevailing in Louisiana. The drier was designed for use with a 100 H.P. boiler. In the main, it consisted of a rectangular sheet-iron box, about 4 ft. × 6 ft. × 20 ft. high, with six shelves, each about 4 ft. square, placed at equal distances from top to bottom on the inside. These shelves were inclined so as to cause the bagasse, which was delivered first to the top shelf, to slide from each shelf to the one below it until the bottom was reached. So as to be certain that the bagasse should continue its course, these shelves were given a slight shaking motion, one side being pivoted to the side of the main shelf, and alternate shelves hinged on opposite sides. The bagasse was delivered to the drier at the top, and removed at the bottom through mechanically-operated, double counterweighted doors, in order to prevent entrance of air. The necessary draft was induced by a 50 in. fan placed near the top of the drier, and this fan not only drew the gases through the drier itself, but also produced the draft for operating the boiler furnaces. The average time required for the material to pass through the apparatus was slightly less than one minute. According to the average figures given, the decrease in the moisture content of the bagasse was about 10 per cent. (54 to 44 per cent.), *i.e.*, an evaporation of about 18 per cent. of the original moisture of the wet bagasse. The average temperature of the flue gases entering the drier was about 253° C., and of those leaving about 112° C. In the case of the undried bagasse, the evaporation tests showed an average of about 1·74 lbs. of water from and at 100° C. per lb. of the wet material with 54 per cent. of moisture. With the fuel dried in the manner described above, an evaporation of 2·54 lbs. of water from and at 100° C. per lb. of the dried material, with a moisture content of 44 per cent. was found. It is thus indicated that the dried bagasse has 46 per cent. greater fuel value, as expressed on equal weights of material. As there was a smaller weight of the dried bagasse, the relative factory fuel values are not shown by these figures. With the average initial and final moisture values stated above, the relative weights of dried and undried bagasse is approximately in the ratio of 82 : 100, so that the percentage increase due to drying is:

$$\frac{100\ (82 \times 2{\cdot}54 - 100 \times 1{\cdot}74)}{100 \times 1{\cdot}74} = 19{\cdot}1 \text{ per cent.}$$

Full data of these experiments are not yet given, for later a full account is to be published as a special bulletin of the Louisiana State Experiment Station.

DRY LIME PROCESS OF RE-WORKING FIRST MOLASSES INTO 96° RAW SUGAR. *By M. Weinrich. La. Planter, 1911, 46, 68.*

Excellent results are stated to be secured by acting on first molasses and raw cane juice with dry lime according to the author's process (see this *Jl.*, 1910, 421). Both the amount of lime and the

temperature are so chosen that a large portion of the impurities are eliminated without destroying the reducing sugar. After liming, the mass is carbonatated, and subsequently the procedure is similar to that used in the beet sugar factory. By the use of this process the author claims that a high-grade granulated can easily be produced on Louisiana plantations, and that the factory could refine this sugar between the grinding seasons, if conveniently situated. In this article are now given figures for the probable profit to be gained by adopting the Weinrich procedure. By the ordinary method now in vogue the yield from 1000 tons of cane may be taken to be—

109·64	tons	of 96° raw sugar; and
34·54	,,	end-molasses of 39·8 purity.

By, however, applying the dry lime process, and converting the first molasses into 96° raw sugar and end-molasses, the author calculates that there would be obtained—

118·59	tons	of 96° raw sugar,
11·16	,,	end-molasses of 36·65 purity.

From 1000 tons of cane about 50 tons of first-molasses could be daily re-worked and treated together with the raw juice, and the purity of the resulting massecuite still kept high enough for boiling to a 95 to 96° raw sugar. Owing to the fact that by this process the viscosity is very much reduced, and about 80 per cent. of the colour removed without any reducing sugar being destroyed, the end-molasses obtained is of much better colour and taste than the ordinary "black strap." The raw sugar resulting from a twice-filtered juice, being free from all traces of iron, would be preferred by refiners, and might, in consequence, command a better price. Wherever limestone can be procured at a reasonable price, the daily extra working expenses would not exceed $130 in a factory grinding 1000 tons of cane. For the U.S.A., Hawaii, Porto Rico, and the Philippines it is computed that the daily extra profit over the ordinary method would be about $424, and for Cuba about $200. For a 1000-ton central the extra machinery including lime kilns and patent rights would be $35,000 f.o.b. New York.

Experiments with Lime Kilns. *By A. Décluy*, *Bull. Assoc. Chim. Sucr. Dist.*, 1911, *28*, 490-500. Compare also this *Jl.*, 1910, 475.

In France, when making quicklime and carbonic acid gas for use in the carbonatation process, it has always been usual to use metallurgical coke. It is, however, now pointed out that, provided certain precautions be observed, fully satisfactory results can be obtained with the cheaper material known as "gas coke," which may contain as much as 13 per cent. of ash, and 1 per cent. of sulphur. In operating the kilns, it is of the first importance that (1) the charging should be

regularly made, and that (2) the proportion of combustible matter in the coke to calcium carbonate in the limestone should be about 14·3 : 100. Good results were obtained in the Voves *sucrerie* in charging an 85 c.m. kiln every two hours, with five trucks each containing a mixture of 49 kilos. of coke (water, 14·0; ash, 12·8; and organic matter, 72·2 per cent.) and 343 kilos. of limestone (calcium carbonate, 95 per cent.). After 30 hours' working in this way analyses of the gases made at half-hourly intervals showed:—

CO_2		O.		CO.
32·5	..	0·5	..	0·5
32·5	..	1·0	..	traces;

and these proportions are considered by the author to be quite satisfactory. As to the proportions of the mixture of coke and limestone, it is emphasized that if the former be in excess, the gas will be less rich in carbon dioxide, and the lime overburnt; whilst if too much limestone be used the gas may be rich but the product will probably be overburnt. When using the carbonatation process, the factory chemist should periodically examine the kiln gases by means of an Orsat apparatus, and if this be done valuable indications as to any irregularity of working may be obtained. If, for example, there is too little carbonic oxide (CO) and an excess of oxygen: then (a) when the appearance of the kiln is normal, there is a leakage between the kiln and pump; and (b) when the kiln burns bright red, the pump is working too quickly. If the gas be poor in carbon dioxide (CO_2), without an excess of oxygen or of carbonic oxide (CO), and the kiln appears to burn normally: then either (a) there is an excess of coke; or (b) the limestone is of very poor quality. When both oxygen and carbonic oxide (CO) are in excess: then either (a) too frequent charges are being made in a given time; or (b) there is an excess of air in the kiln.

Use of Caustic Potash to Destroy the Reducing Sugar in Sugar Products when Determining Raffinose. *By H. Pellet. Sucr. Belge, 1910, 39, 154-155.*

Commenting upon the recent article by Jolles on this subject (see this *Jl.*, 1911, 109), the author points out that the use of alkalis for destroying reducing sugar is by no means novel, he having investigated the method very fully some years ago (*Bull. Assoc. Chim. Sucr. Dist.*, 1897-1898, 605-606). His procedure is to place 50 c.c. of a normal sugar-weight solution in a 200 c.c. flask, add 5 grms. of caustic potash, and heat on the boiling water-bath for five minutes. After cooling the solution, it is almost exactly neutralized with acetic acid, defecated with a slight excess of basic lead acetate, and the volume completed to 200 c.c. Finally, the liquid is mixed, filtered, and polarized in the 200 mm. tube. By this treatment a slightly

levo-rotatory body is formed at the expense of the levulose; and of this account must be taken when products containing much reducing sugar, such as cane molasses, are under examination, although for ordinary beet products, or sugars containing 3 to 5 per cent. of reducing sugar, the amount formed is negligible, and no correction is necessary.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E. Chartered Patent Agent, 6, Lord Street, Liverpool; 77, Market Street, Bradford; and 285, High Holborn, London.

ENGLISH.—Applications.

3004. H. Sefton-Jones (communicated by J. Snoep, Holland). *Manufacture of saccharin.* 6th February, 1911.

4192. J. Sykora. *Apparatus for the production of moulded sugar.* (Complete specification.) 18th February, 1911.

ENGLISH.—Abridgments.

4855. P. Kestner, Lille (Nord), France. *Improvements in or relating to sugar crystallizing processes.* Date claimed for Patent being date of first Foreign application (in Belgium). 26th February, 1909. Date of application (United Kingdom), 26th February, 1910. This invention relates to a continuous process for obtaining crystallized sugar from a syrup, consisting in evaporating the water from this syrup in a continuous evaporator, allowing the concentrated syrup to flow into a series of crystallizers arranged in battery form, and cooling it progressively as it flows therethrough in a continuous stream.

11706. A. Boivin, Paris, France. *Improvements in or relating to machines for breaking and packing sugar.* Date of application 11th May, 1910. Patent of addition to 25246, 2nd November, 1909. This invention relates to a machine for breaking and packing sugar comprising a breaker, a feed device for conducting the cakes to the breaker and a boxing device for arranging the pieces in packing boxes, according to prior patent, characterized by a pair of pushers to which reciprocating movements are imparted and which serve to conduct the cakes from a conveyor device to a breaker in a continuous manner, the movements of these pushers being regulated in such a manner that each pusher does not recede until a moment after the other pusher has begun to advance.

13320. W. J. Sluka, Vienna, Austria. *Machine for transforming boiled sugar into a creamy paste.* Date claimed for Patent

being date of first Foreign application (in Austria), 1st February, 1910. Date of application in United Kingdom, 1st June, 1910. This invention relates to a machine for transforming boiled sugar into a creamy paste, in which the boiled sugar is cooled during its passage from the receptacle holding it to the devices which work or knead it, by a current of air produced by a fan, bellows or the like.

GERMAN.—Abridgments.

229264. Dr. Emil Preissler, of Hanover-Linden. *An apparatus for catching substances floating in liquids, more particularly sugar juice and drain.* 31st March, 1910. This consists of rotary cylindrical brushes, to which the liquid is conveyed in such a way that it can flow away in an opposite direction to that of the rotation of the brushes, and also in spikes or the like arranged like a grate or comb, side by side, with narrow intervals between them and engaging with these brushes, which spikes catch and remove all floating substances taken up by the brushes.

229597. Hermann Hillebrand, of Werdohl, Westphalia. *A double knife box for beetroot slicing machines and the like.* 21st February, 1908. In this machine the bar carrying the front knife is provided with a recessed rear extension on which a removable bar, itself of known type, is placed, which serves as an abutment for the rear knife independently of the front knife.

229627. Fritz Tiemann, of Berlin. *A process and apparatus for continuously cleansing solutions more particularly sugar juice.* 16th December, 1909. In this process the deposited sludge is removed from the lower part of a deposition vessel heated to a high temperature and again added to the fresh juice to be purified in the upper part of the deposition vessel. An apparatus for carrying out this process comprises a conveyor arranged at the lower part of the deposition vessel, which forces the sludge into a heating apparatus and then into the upper part of the deposition vessel.

229665. Maschinenfabrik Grevenbroich, of Grevenbroich. *An apparatus for filling flat sugar moulds, more particularly on the Adant system.* 24th June, 1909. In this apparatus feed trunks are provided which connect the moulds with a collecting vessel and are provided at their outlet apertures with means for closing them, all the closing members being connected with one another by suitable means in such a way that they may be simultaneously opened or closed and the closing members of the feed trunks connected with a displaceable adjusting ring carried by inclined surfaces in rollers or the like. The upper cover of the flat sugar moulds is also provided with automatic air valves which are connected with the chambers of the flat moulds.

229603. Julius Kantorowicz, of Breslau. *A process for making dry starch products yielding with cold water a liquid adhesive.* 11th March, 1909. Starch, soluble starch or clear dextrine is agitated with water and non-volatile alkalines or alkaline salts or with acids, substances which easily yield oxygen or chemicals releasing oxygen into a paste and this paste is thickened and dried directly or after previous thickening on hot cylinders or plates.

229949. Juan Ost, of Turin, Italy. *A process for freeing sugar crystals from adherent syrup by means of absorbent substances and apparatus for carrying out the same.* Patent of Addition to Patent No. 211267, of 22nd January, 1907. 20th April, 1910. This is an improvement on the process described in the original Patent No. 211267, and by it the action of the absorbent substances on the sugar takes place at temperatures of from 20-60° C. and in an atmosphere of 90 to 100 per cent. relative moisture. An apparatus for carrying out this process is described in a prior patent of addition, No. 217069, and in this the sugar and the capillary substances are first passed together through a revoluble mixing drum and then into a co-axially placed rotating straining drum for the purpose of separating the purified sugar crystals and the capillary substances, and by the present improvements the straining drum is firmly connected with the mixing drum without any interval, and a pipe which serves as a shaft on which the drum rotates is provided for introducing hot air into the drums. Another feature is that in order to regulate the transference of the mixed material from the mixing drum into the straining drum, and also the capillary substances from the straining drum to the outside, two bodies having spiral beaters or vanes are arranged on the tubular shaft so as to be capable of being displaced axially from the outside.

UNITED KINGDOM.

IMPORTS AND EXPORTS OF SUGAR

To End of February, 1910 and 1911.

IMPORTS.

Unrefined Sugars.	1910. Tons.*	1911. Tons.*	1910. £	1911. £
Russia	....	....	....	....
Germany	37,024	84,243	466,239	800,169
Netherlands	3,398	1,853	40,238	16,632
Belgium	1,441	1,956	17,583	18,959
France	58	17	880	138
Austria-Hungary	24,867	20,083	324,593	197,817
Java	1	2	4	24
Cuba	....	....	....	....
Dutch Guiana	2,393	1,125	33,213	15,322
Hayti and San Domingo	7,093	450	95,713	4,450
Mexico	136	502	1,711	5,524
Peru	5,746	10,336	66,989	93,447
Brazil	12,160	835	141,574	6,151
Mauritius	1,611	4,975	17,158	45,703
British Guiana	....	....	....	....
Straits Settlements	152	....	1,792	....
Br. West Indian Islands, Br.Guiana & Br.Honduras	15,446	8,096	208,013	99,348
Other Countries	3,716	3,000	45,918	26,565
Total Raw Sugars	115,243	137,474	1,461,618	1,330,249
Refined Sugars.				
Russia	69	6,476	1,065	72,929
Germany	61,635	67,295	916,754	844,739
Holland	16,388	21,065	251,946	280,377
Belgium	4,859	6,148	77,169	81,274
France	10,232	1,024	156,916	14,927
Austria-Hungary	31,291	37,977	471,270	485,111
Other Countries	3,755	51	59,071	597
Total Refined Sugars	128,230	140,037	1,934,191	1,779,954
Molasses	20,623	20,859	99,163	84,161
Total Imports	264,096	298,370	3,494,972	3,194,364

EXPORTS.

British Refined Sugars.	Tons.	Tons.	£	£
Denmark	580	648	7,716	7,148
Netherlands	618	564	9,175	7,234
Portugal, Azores, & Madeira	370	222	4,901	2,437
Italy	63	345	820	3,971
Canada	475	1,122	7,237	16,450
Other Countries	1,114	2,510	19,817	37,903
	3,221	5,412	49,666	75,143
Foreign & Colonial Sugars				
Refined and Candy	84	178	1,549	2,675
Unrefined	543	2,127	7,263	22,891
Various Mixed in Bond	....	....	....	....
Molasses	75	23	530	147
Total Exports	3,923	7,740	59,008	100,856

* Calculated to the nearest ton

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1911. Tons.		1910. Tons.
Total Receipts January 1st to Feb. 23rd	270,731	..	364,840
Receipts of Refined ,, ,, ...	72	..	—
Deliveries ,, ,, ...	270,731	..	364,840
Importers' Stocks, February 22nd	None	..	3491
Total Stocks, March 1st	99,000	..	209,030
Stocks in Cuba, ,, ...	225,000	..	254,000
	1910.		1909.
Total Consumption for twelve months ..	3,350,355	..	3,257,660

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR FOR 1909, 1910 AND 1911.

(Tons of 2,240lbs.)	1909. Tons.		1910. Tons.		1911. Tons.
Exports	125,353	..	217,272	..	142,217
Stocks	107,775	..	157,636	..	81,051
	233,128	..	374,908	..	223,268
Local Consumption (1 month)..	5,250	..	5,760	..	5,850
	238,378	..	380,668	..	229,118
Stock on 1st January (old crop)..	....	..	....	..	....
Receipts at Ports up to 31st Jan.	238,378		380,668		229,118

Havana, 31st January, 1911. J. GUMA.—F. MEJER.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION OF SUGAR FOR TWO MONTHS ENDING FEBRUARY 28TH.

	IMPORTS. 1909. Tons.		IMPORTS. 1910. Tons.		IMPORTS. 1911. Tons.	EXPORTS (Foreign). 1909. Tons.		EXPORTS (Foreign). 1910. Tons.		EXPORTS (Foreign). 1911. Tons.
Refined	120,468	..	128,230	..	140,037	172	..	84	..	178
Raw	105,631	..	115,243	..	137,474	362	..	543	..	2,127
Molasses	31,538	..	20,623	..	20,859	24	..	75	..	23
	257,637		264,096		298,370	558		702		2,328

	HOME CONSUMPTION. 1909. Tons.		1910. Tons.		1911. Tons.
Refined	122,501	..	127,404	..	134,970
Refined (in Bond) in the United Kingdom........	93,341	..	92,533	..	100,760
Raw	16,859	..	21,284	..	16,739
Molasses	22,260	..	23,821	..	24,098
Molasses, manufactured (in Bond) in U.K........	12,178	..	13,497	..	13,461
Total.........................	267,139	..	278,539	..	290,028
Less Exports of British Refined..................	4,033	..	3,221	..	5,412
	263,106		275,318		284,616

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, FEB. 1ST TO 25TH, COMPARED WITH PREVIOUS YEARS.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1911.
139,300	1,644,040	511,000	833,400	332,170	3,459,910

	1910.	1909.	1908.	1907.
Totals ..	2,850,110	3,236,710	3,370,010	3,383,490

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING JANUARY 31ST, IN THOUSANDS OF TONS.

(Licht's Circular.)

Great Britain.	Germany.	France.	Austria-Hungary	Holland, Belgium, &c.	Total 1910-11.	Total 1909-10.	Total 1908-09.
1921	1308	708	615	235	4788	4757	4537

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1910-1911. Tons.	1909-1910. Tons.	1908-1909. Tons.	1907-1908. Tons.
Germany	2,602,000	2,027,000	2,082,848	2,129,597
Austria	1,570,000	1,257,000	1,398,588	1,424,657
France	740,000	801,000	807,059	727,712
Russia	2,115,000	1,145,000	1,257,387	1,410,000
Belgium	285,000	250,000	258,339	232.352
Holland	225,000	198,000	214,344	175,184
Other Countries	590,000	460,000	525,300	462,772
	8,127,000	6,138,000	6,543,865	6,562,274

THE

INTERNATIONAL

SUGAR JOURNAL.

No. 148. APRIL, 1911. Vol. XIII.

☞ All communications to be addressed to the Editor, Office of "The Sugar Cane," Altrincham, near Manchester. All Advertisements to be sent direct.

☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

Cheques and Postal Orders to be made payable to NORMAN RODGER, Altrincham.

The Editor will be glad to consider any MSS. sent to him for insertion in this Journal and will endeavour to return the same if unsuitable; but he cannot undertake to be responsible for them unless a stamped addressed envelope is enclosed.

NOTES AND COMMENTS.

Lord Denbigh on a Subsidized Sugar Industry.

Lord Denbigh has just lately been making another appeal by means of letters to the press for encouragement for a sugar beet industry in this country. In the course of a long communication to the *Yorkshire Observer*, he combatted the rather silly idea advanced by that Liberal paper, that the advocates of a duty-free industry in this country were asking in effect that the revenue should be deprived of the £3,000,000 it at present obtained from the sugar duties. Parenthetically we might remark here, that between taking off the sugar duties altogether, as the present Government is being asked to do by a section of its supporters, and taking off the duty on that proportion which is produced at home, most unbiassed economists would think the latter, if not actually an ideal arrangement, at any rate the lesser evil of the two. But Lord Denbigh proceeds to show that, in his own view at any rate, there is no fear of our whole supply of sugar being produced at home by means of this rebate. He himself is more attached to the plan of aiding the industry only for a number of years till it is firmly established, and in pursuance of this idea he offers a few figures to show what loss in revenue might actually be expected. He says he would look on the industry as established in this country if half a dozen factories in different parts were working satisfactorily

and returning fair profits to the shareholders. As no factory should be erected to turn out less than 5000 tons of sugar per annum, he assumes these six would between them produce, say, 30,000 tons; if no excise duty were imposed on this, the revenue might lose as much as £60,000—no great slice out of three millions, especially when the compensatory benefits are considered. As an instance of these, it can be shown that the preference so accorded would bring to the factory an additional revenue of nearly £10,000 or about 8 per cent. on the capital. This sum would probably make all the difference between profit and loss in the early years of struggle.

We certainly think that such a plan of giving temporary help to a new industry, till it has got over its initial difficulties, might be consistently adopted even by a Liberal Government. If they remain averse to making the preference permanent and thereby insuring a measure of protection for our own agriculture, they can always abolish the arrangements by a clause in the next Budget; and the fear of making the path of a subsequent tariff reform Government smoother should not deter them from taking a step that would ensure fair play for a new branch of our agricultural industry.

A Norfolk Project.

But in the meanwhile, it is a pleasure to record that some serious and practical attempt is being made in Norfolk to start a factory. Mr. E. S. Ali Cohen, a Dutch gentleman interested in the sugar industry abroad, was the chief speaker at a representative meeting held in Norwich at the beginning of March, to consider the possibility of starting a sugar industry in Norfolk. Mr. Cohen, who is acting in conjunction with a syndicate, proceeded to state at some length what terms he and his friends would be willing to offer if Norfolk farmers took seriously to beet growing. He announced that arrangements had been made to start at least one sugar factory in 1912, near to Norwich, and that they were only just prevented, by lack of time to complete details, from having the factory going this Autumn. In the meanwhile he wished the farmers to grow for export to Holland as much beetroot as possible this year. For this he was prepared to pay 20s. per ton, delivered at the nearest seaport. He offered to provide free seed, to bring over seeding machines to sow the crop with, and to give free expert supervision of the crops. When the factory was built, they would pay 20s. per ton for the roots delivered at the factory, plus a bonus of 6d. for all beet containing over 17 per cent. grown over an area of at least 25 acres, and an extra 6d. per ton if the factory pays 5½ per cent. dividend. He pointed out in addition that the leaves and tops had a fodder value of at least 20s. per acre, and that the land would be improved for other crops. He expressed the hope that the farmers would come forward in sufficient numbers to sign

contracts for beet growing, without which the attempts of his syndicate must fail.

Mr. Rider Haggard, well-known not only as a successful novelist but also as an agriculturist of considerable eminence, confessed that his own experience in beet growing had been only a small one and, he grieved to add, an unsatisfactory one. The net result on two acres of land was a loss of £13. But in the course of a visit to Denmark to enquire into the systems of co-operative agriculture practised in that country, he had had ample evidence offered him of the profitableness of a beet sugar industry. The factories made 20 per cent. profit, and the farmers got £3 per acre net profit year in and year out. He was certain that whatever profits—and they were large—were made in Denmark, could be made also in East Anglia, where the climate was still more favourable. He considered, however, that till Mr. Cohen's factory was established and the farmers could become co-owners of it, it was doubtful whether sugar beet growing would pay in Norfolk, especially if no bye-products were returned to the farmer.

The Sugar Cane Froghopper.

There has always been some doubt as to the identity of the sugar cane froghopper, but in some recent *Proceedings* of the Agricultural Society of Trinidad the matter seems to be set at rest. In his article in the *Agricultural Record*, Vol. II., 1890, p. 126, Mr. J. H. Hart, F.L.S., mentioned that Mr. R. McLachlan, F.R.S., had decided that this insect belonged to the family Cercopide, but it could not yet be ascertained that the particular species was known as described. Subsequently the insect was referred to by Hart, Collens and Barrett as *Tomaspis postica*, Walker. Mr. Heidemann of the United States Department of Agriculture, to whom Mr. Urich of Trinidad referred a series of sugar cane froghoppers, determined them as two species, viz., *Tomaspis postica*, Walk, and *Tomaspis postica*, var. Walk. Professor E. D. Ball, an authority on Cercopidae, was good enough to offer Mr. Urich his help in connection with the identification of these insects, and after examining a long series from Trinidad determined the sugar cane froghopper as *Tomaspis, varia Fabr.* In his letter the Professor mentions that the true *T. postica* was taken on sugar canes in Mexico, but that this species is quite different to the Trinidad sugar cane froghopper.

The Lectureship in Sugar at Glasgow.

We are glad to learn that the post of Lecturer in Sugar Manufacture, which has just lately been created by the Governors of the Glasgow and West of Scotland Technical College to date from September next, has just been filled by the appointment of Mr. Thomas H. P. Heriot. This gentleman is no stranger to our readers,

he having frequently contributed to our columns not many years ago; his chief work having been a series of papers on simple methods of chemical analysis, which was reprinted in book form under the title of "Science in Sugar Production," and is still selling. Mr. Heriot was in fact attached to our staff for some time till he finally left to take up an appointment in Trinidad. This was followed by two years on a sugar estate in Natal, whence he now comes to take up his new post. We are sure he will fully justify his selection, as he has been a close and careful student of his profession, and has had a comprehensive practical experience of the working side of the industry.

The late Mr. J. H. Hart.

We regret to learn of the death of Mr. J. H. Hart of Trinidad, which occurred on February 20th last. He had been in bad health for some time and his death was therefore not wholly unexpected. His name will have been familiar to our readers, not only on account of the papers appearing in this *Journal* from his pen a decade ago, but also on account of his work in Trinidad, where he served for 18 years under the Botanical Department, latterly as its head. Previous to that he had been for 12 years in the service of the Jamaican Government. The Bulletins of agricultural information issued by the Trinidad Government were for many years prepared under his supervision, and indeed he spent the final months of his life preparing a book on cacao, which he unfortunately did not live long enough to see published.

The Mauritian Sugar Crop, 1909-10.

A Colonial Office report of Mauritius recently published, gave particulars of the sugar crop for the season ending July last. The exceptionally favourable climatic conditions resulted in the record of 246,560 metric tons, the largest previous crop having been that of 1903, when 215,697 tons was produced. This compares well with 1908-09, when the crop was only 191,500 tons. There were two developments during the year which had an appreciable effect on the local market. Considerable shipments of white sugar were made to London, and the direct shipment of sugar to India was undertaken by European firms. The average selling price as determined by the local Chamber of Agriculture was about 11s. 6d. per cwt.

British India.

The final General Official Memorandum on the 1910-11 season of the sugar industry in India, states that the area under cultivation in seven provinces, which represent 98·5 per cent. of the total, amounted to 2,131,500 acres, a net increase of 18,700 acres as compared

with the previous year. The total yield expressed as raw sugar was estimated at 2,226,400 tons or an increase of almost 100,000 tons. The weather conditions had been generally favourable to the production of a good crop, rain being abundant. The least satisfactory return was made by Eastern Bengal and Assam, where the crop was damaged by floods in several districts and affected by red rot disease in others.

A REVOLUTION IN SUGAR PRODUCTION.

THE MANUFACTURE OF WHITE SUGAR IN JAVA.

In our review of Mr. Deerr's new book we had occasion to refer to a very important statement recently made by Mr. H. C. Prinsen Geerligs, on the manufacture of white sugar in Java. The reference arose from the fact that Mr. Deerr, in his chapter on "Carbonation," alluded to the use of the double carbonation process in a few factories in Java, and perhaps elsewhere, and went on to remark that "the best white sugars of Mauritius made by a defecation process combined with the use of sulphur and phosphoric acid are equal to any that he has seen prepared by the carbonation process."

This was very interesting, because Mr. Prinsen Geerligs had just announced a new departure in Java with regard to the carbonation process for the production of white sugar for the Indian market. The manufacture of white sugar in Java has made enormous progress during the last few years. Two or three thousand tons a year were formerly made for consumption in Java and the neighbouring islands, but in 1903 Java began to export white sugar to British India, which realised such good profits that the production largely increased. The quantity produced, in 1905, was 70,000 tons, and, in 1909, 250,000 tons, while many factories are still changing their plant in order to make white sugar in future. This white Java sugar has driven German and Austrian sugars from the Indian markets. In the white sugar factories is to be found all the machinery necessary for double carbonatation, a process which enables them to deliver to the market white sugar of *première qualité*, which keeps well during transport and warehousing in the tropics. But, Mr. Geerligs goes on to say, the process is very costly, and a factory equipped for the production of white sugar cannot conveniently turn out the raw sugar below No. 16, Dutch Standard, which is alone admitted into the United States and Japan. This, he points out, is a situation of danger for the white factories because other countries, British India for instance, might also exclude the importation of white sugar. This has given serious food for thought to Mr. Geerligs and the Java planters, and the remedy proposed is a radical one. It is to substitute a simple defecation with sulphurous acid for the complicated and costly process

of double carbonatation, and thus to confirm Mr. Deerr's comment quoted above. At present the Java planters have to choose between fitting up their factories with expensive machinery for double carbonatation in order to turn out white sugar for the Indian markets, or to remain as they are in order to produce raw sugar for the refiners in Japan, America, Hong Kong, or Europe. They now seek for a third alternative which will enable them to turn out white sugar or raw sugar with an inexpensive plant capable of either process.

To accomplish this they have decided to purify the juice in a less energetic manner than by the carbonatation process, and to bring in certain improvements in the ordinary defecation which may enable them to produce a whiter sugar. Various more or less secret processes have been tried, but gradually one after another of the chemical agents for the manufacture of sugar have been discarded and the mysterious cloud of secrecy has been dispelled.

The process now adopted is very simple. The juice from the mill is mixed cold with 5 to 6 litres of milk of lime, at 15 Baumé, to 1000 litres of juice. Sulphurous acid gas is introduced into the juice until the alkalinity is just neutralized. The neutralized juice is then heated to boiling point and run into the decantation tanks. When the precipitate has been well separated the clear juice is decanted, and goes to the evaporation, while the precipitate goes to the filter presses, the resulting juice being mixed with the decanted juice. The juice is evaporated and then boiled to grain without any addition of first syrup. The syrup is either treated again with sulphurous acid up to a slightly acid reaction or merely run off without treatment. The boiled mass goes into the centrifugals without being cooled, and the syrup is run off without washing the crystals. The sugar is then mixed with syrup (*clairce*) and passed through a second series of centrifugals, where washing takes place after the syrup has been run off. After the washing dry steam is applied in the centrifugals, the sugar is then cooled in the air, sifted and bagged.

The syrups from this second centrifugalizing and from the washing are mixed and boiled to grain, with the juice. The lower first syrup is diluted, stirred, treated again with sulphurous acid if necessary, and then boiled to grain. It is boiled very "stout," cooled very slowly in the "*cristallisoirs à movement*," diluted if necessary, and eventually passed through the centrifugals without washing. The syrup from this is exhausted molasses. The unwashed sugar may be sold as raw sugar *tel quel*, or it may be mixed with some first *massecuite* in a vessel for crystallization in motion. This will go through the same treatment of double centrifugalling, first to remove the syrup and, secondly after mixture of the sugar with the *clairce*. Thus the first product is centrifugalled twice, and the second even three times. The final result is the separation of the original juice into one quality of white sugar and an exhausted molasses of about 30 apparent purity. The

whole manufacture is effected without re-entry of syrup, and without second products, and, as Mr. Geerligs claims, "we have succeeded in carrying out this work without the unknown and exaggerated losses which might cause us to lose the advantage of obtaining our whole product in the form of white sugar instead of raw sugar." He adds that "it may easily be understood that it was only after much feeling of their way and many fruitless trials that they arrived at the final result. The process here described has not, however, been carried out word for word in all the factories; each one follows his own method. The quality of the sugar produced by the system here described differs in no way from that produced by carbonatation; it is as white, and preserves its whiteness for the same time. Moreover, the *sulfitation* has the advantage of its extreme simplicity and its very compact plant. The whole installation suffices for making raw sugar, and they only have to add a sulphur furnace with the necessary pipes, and a few more centrifugal machines, in order to make white sugar. If by chance the condition of the market makes it more advantageous to make raw sugar rather than white sugar, it is only necessary, so to speak, to turn a handle in order to transform your white sugar factory into a raw sugar factory."

This is, as we said in our review of Mr. Deerr's book, a great and most impressive revolution in sugar production if carried out successfully and on a large scale. If this can be done with the very impure juice coming from a modern triple or quadruple cane mill, how much more easy should it be with the pure juice from a beetroot diffusion battery. Those who are young enough may live to see the day when the cumbrous and costly process of carbonatation has become a thing of the past, even in a beetroot sugar factory. Pioneers of the beetroot industry in this country, please take note.

George Martineau.

The Midland Agricultural and Dairy College, Kingston, near Derby, which in the years 1907-1908, carried out a large amount of experimental work on sugar beets, has arranged, at the request of the Board of Agriculture, to grow this crop on a commercial scale in the coming season.

Although the rather low price of sugar has delayed decisions regarding several new machinery propositions, manufacturers in this branch of engineering are fairly busy. Messrs. George Fletcher & Co., Ltd., Derby, inform us that, amongst other important contracts, they have in hand the construction of a complete Heavy Type Multiple Cane Grinding Plant and General Factory Equipment for Formosa, a Triple Effet Evaporating Apparatus for South America, and a large Vacuum Pan for Australia.

THE SUGAR BEET.*

Its Mode of Cultivation and Development.

By Ed. Koppeschaar.

(Continued from page 134.)

As to the cause and the extent of the troubles encountered in the manufacturing process just described, a short explanation may not be out of place here. As seen in our manufacturing diagram, the agency that changes the dark-coloured, sour, unsavoury-smelling raw juice into a bright, light, yellowish-coloured, sweet-smelling, clean juice is lime—*common quicklime*. However useful and indispensable this simple agent is for accomplishing such an extensive change, experience has taught us that the less lime there is left in the thin-juice which is about to enter the evaporating station, the better this juice will evaporate its surplus of water,* the less chance will there be for the tubes to get covered with incrustations,† the easier the thick-juice will be induced to crystallize out, and the smoother and quicker the crystal mass will be spun off in the centrifugals. When the raw material, the beets, is as mature and elastic as can be desired, which will be the case in the beginning of the campaign, there will be no difficulty in producing a thin-juice containing about 0·005 to 0·007 per cent. of lime but with a sufficient alkaline reaction (caused by the hydroxides of sodium, potash and ammonia) in addition to prevent any chance of inversion (which means loss of sugar). This small percentage of lime is most probably formed by lime salts of organic acids, originally present in the beets, escaping the filtering process while soluble. On the other hand, towards the end of the campaign, when beets that have been lying in big heaps are worked up, or batches of more or less rotten beets are tackled, the utmost care and supervision at the carbonatation pan cannot prevent occasional complaints coming from the sugar end of the factory. These complaints imply difficulty in crystallizing, dark juices, and trouble in centrifugalling. They coincide with a high lime content of thin and thick-juices. The worst outcome of this (coinciding with a lime content of about 0·1 in the thick-juice), though seldom happening, is that the juice refuses to crystallize out.

An able factory manager under unfavourable circumstances will not take refuge behind bad beets, but in the above named case, as well as in cases of minor complaints, will resort to those means within his reach to combat the trouble. He will slice coarser, lower the

* About 100 lbs. of water are to be evaporated for every 100 lbs. of beets sliced; probably viscosity plays a rôle in this case.

† Which incrustations, of course, mean less economical evaporation and increased output of coal for the factory.

temperature of the battery, keep as few cells as possible at work, heat his raw juice higher, work as quickly as he can, divide the dose of lime, as much as his kilns will allow, between the first and second carbonatations, and finally apply those remedies in the vacuum pans which will lessen the difficulties. Evidently, however, there will always be a loss of sugar (as the extraction in the battery goes on under unfavourable conditions and more limecake is formed), and loss of time, besides anxiety lest the quality of the sugar may give rise to complaints as well (especially so in white sugar factories); so that a clause, included in most contracts in regard to the refusal of bad, inferior, or rotten beets, is well justified.

Having dealt with the five points, to which we thought it might be good to draw the farmers attention at some length, some information about the by-products accruing from a sugar factory, and some further hints as to the choice of fertilizers may find a place here.

From the *modus operandi* previously outlined (this *Jl., 1911,* 130), the farmer will see which by-products are to be expected. These are not only a considerable financial asset to a sugar factory, but also, in our opinion, go a long way towards ensuring that the sugar factory shall form a close connection with the agricultural side of the industry. To deal at some length with this aspect of the problem will no doubt be welcome to our readers; we will therefore devote some space to it.

The first by-products we must refer to are the *beet leaves* and *heads*. As already mentioned, the heads, while containing like the ends from six to eight per cent. of sugar, when the rest of the beet contains 15 to 17 per cent., are not a desirable material for the manufacturer on account of the high salt content and high "harmful" nitrogen content,* both tending to increase the melassigenic ratio. To leave them on the land, however, to form a beneficial green manure is not advisable on account of the risk of insect pests. The best way to dispose of them is to feed them to the cattle in the form of ensilage. Not only is it better digested by the cattle when it is ensilaged, but when fresh, the high content of oxalic acid sometimes causes sickness among the animals. In ensilaged leaves and heads only a small per cent. of oxalic acid is left, and this does no harm.

The ensilaging itself can be done in various ways. Upright, clean, smooth walls, without corners, will best serve the purpose, and therefore a circular-walled pit is a good plan. The ensilaging being a fermentation process must be undertaken with care, and not too hurriedly, and the mass must be trodden in evenly. If no ensilage pit is available, the leaves and heads may be heaped up and pressed down by a layer of earth.

* "Harmful" nitrogen, it will be remembered, is the molasses-forming part of the total nitrogen.

The following data will assist the farmer to compare his food rations:—

Beet leaves and heads.

	Fresh.		Ensilaged.	
Dry substance	16·2		23	
	Raw food.	Digestible.	Raw food.	Digestible.
Protein	2·3	1·7	2·4	1·5
Fat	0·4	0 2	0·7	0·3
Starchy substances	7·4	5·9	9·1	7·2
Raw fibre	1·6	1·1	3·4	2·5

The other by-product that goes to figure as cattle food is *pulp*, which consists of the beet slices after the sugar has been extracted from them. When the extraction has gone as far as practice allows, leaving 0·2 to 0·4 per cent. of sugar in the pulp (or *cossettes* as they are called abroad), these are freed of part of their water by pressing them, and either in that pressed form or after being air-dried they form a good cattle food. 100 lbs. of beets will give about a like amount of wet pulp, and these in turn will give about 60 to 65 lbs. pressed pulp. Fed fresh to the cattle, this pressed pulp forms an excellent food if a certain proportion of nitrogenous food, *e.g.*, oil cake, bean meal, &c., is added to it. The analysis of fresh pressed pulp varies according to how much it is pressed; it may contain, for example—

Dry substance	15 per cent.	
	Raw food.	Digestible.
Protein	1·3	0·7
Starchy substances	9·9	8·5
Fat	0·1	—
Raw fibre (cellulose)	3·0	2·2

The largest part of the pressed pulp, however, must be ensilaged or simply heaped up, thus producing a soured ensilaged pulp, which is readily eaten by the cattle. An analysis of this sour ensilaged pulp shows:—

Dry substance	11·6 per cent.	
	Raw food.	Digestible.
Protein	1·–	0·5
Starchy substances	7·2	5·4
Raw fibre	2·3	1·2
Fat	0·2	0·1

Of course, certain losses will arise, and it is advisable, as with leaves and heads, to ensilage with care in clean pits.

A decided improvement on ensilaging is the drying process.* If we consider that 100 lbs. beets, giving 50 to 70 lbs. of pressed pulp, will leave us only about 6 lbs. dried pulp, the saving in cost of transport does not need enlarging on.

*In 1905-06, 42 per cent. of the 370 sugar factories in Germany had drying installations at work.

There is here no loss like the considerable loss in weight (about 30 per cent.) which occurred when ensilaging; and when soaked before feeding, the cattle like this food as well as they do ensilaged sour pulp. It makes some difference in the percentage composition whether the pulp is dried by steam or by direct exposure to fire-gases, but on the whole we can give its composition (to take as a basis for food rations) as follows:—

Dry substance	88·8 per cent.	
	Raw food.	Digestible.
Protein	8·1	4·1
Starchy substances	58·5	50·4
Raw fibre	17·6	12·7
Fat	0·6	—

A few words may be added about a product that is turned out in some factories, which we may call a sugar-rich pulp in dry form. The analysis shows:—

	Per cent.
Dry substance	91·46
Protein	6·97
Fat	0·4
Starchy substances*	68·25
Raw fibre	11·81

But we must state that this sugar-pulp, while there is no doubt as to its being a very good food for cattle and horses, is no real by-product, but represents a form in which sugar may be sold. Its profitable manufacture depends on the prices of cattle food, and where a sugar-making industry is still in its infancy, too much attention should not be given to this special output.

The last by-product of all the manufacturing processes is *molasses*, generally sold to distilleries, but which may however to a limited extent be utilized as food for cattle, &c. A beet sugar factory produces two to four per cent. on weight of beets of molasses containing on the average

Dry substance	80 per cent.	
	Raw food.	Digestible.
Protein	10·5	5·4
Starchy substances†	60	55·0
Saline ,,	10	

Its chief value, as is obvious, lies in the 50 per cent. sugar, a digestible carbohydrate. But it is a by-product that for feeding purposes must be mixed with nitrogenous substances, such as bran and shorts, in which form it makes a splendid cattle food.

* Of which about 35 per cent. is sugar.
† Of which about 50 per cent. is sugar.

To recapitulate, we give the following tables to show digestibility percentages:—

	Digestible. Albumen.	Carbohydrates. Starchy substances.	Carbohydrates. Raw fibre.	Fat.	Quantity to be expected from
Sugar beets	0·9	20·3	0·5	—	100 lbs.
Beet leaves and heads, green	1·7	5·9	1·1	0·2	varies
Ensilaged beet leaves and heads	1·5	7·2	2·5	0·3	varies
Pressed pulp, fresh	0·7	8·5	2·2	—	60 lbs.
Pressed pulp, ensilaged	0·5	5·4	1·2	0·1	40 ,,
Dried pulp	4·1	50·4	12·7	—	6 ,,
Sugar pulp	4·3	64	—	—	11 ,,
Molasses	5·4	54·9	—	—	3 ,,

Of the by-products that are of value to the farmers as manure, we note in the Table of Manufacture given in our last chapter, first of all, *the earth* that has been washed off from the beets and settled in basins. The quantity of this adhering earth*, in reality representing the tare of the beets, will depend on the kind of soil in which the roots were grown. Heavy clay adheres much more than sandy loam. The shape of the beet comes into play too, and the weather at the time of harvest will also influence it. The contents of these basins are usually disposed of gratis, though after having been properly exposed to the air, they form an excellent means of improving poor soils, as a dressing for pastures, &c. But for beet-fields its use cannot be recommended on account of the chance of nematode infection. Of analyses of this earth there are few records, but the writer has convinced himself of its extraordinary fertility † by bringing into cultivation an old earth-basin of about two acres surface, after proper drainage. The mixing of this earth with lime disinfects it, so mixing with limecake should give a still more valuable mixture.

The most important manurial by-product, whose value is often greatly under estimated, is the *limecake.* As will be seen from the Table of Manufacture, it is formed by filtering off the carbonated and limed raw juices. While the lime in the juice combines with carbonic acid, this voluminous combination absorbs some nitrogen, phosphoric acid and potash from the original beet which were extracted in the same process as the sugar, *i.e.*, in the battery of diffusion cells.

* It will be wise to settle right from the beginning how to deal with this earth and where to dispose of it. The proper dimensions and dispositions of the settling basins will prevent complaints arising from the inflow of the offal waters of the factory. Figuring it at about 10 per cent. of the weight of beets and taking 1400 k.g. per cubic metre (87·2 lbs. per cubic foot) it will be advisable to reserve at least 2½ acres surface for these basins for a 1000 ton sugar factory.

† It was given out in small plots to the factory hands who reaped heavy crops of beans, potatoes, &c., each year without extra manuring.

Though it is evident that we will therefore find these useful fertilizing elements in the limecake (all of them in available form) it is not this part of the limecake which we wish to draw our readers' attention to.

The main value of limecake is in the *lime content*, and the action the lime exercises on our soils. That lime will neutralize sour peaty soils is a fact that should lead to its more extensive application. (The writer has handled many ship-loads of beets grown on peat soil; they were somewhat on the small side, but had a satisfactory sugar percentage.) Thus the growth of nitrifying bacteria, which cannot stand acids, will be favoured by lime. On heavy clay soils, hard to plough and impervious to moisture, lime is well known to exercise a beneficial influence. It will make the soil more porous, and easier to cultivate. Besides this purely physical action, leading to those soil properties so much needed for our beets, lime brings unavailable food stores* within reach of the roots by changing them into available form.

As to analyses, we may remark here that the composition will greatly depend on the amount of lime used, which ranges from 1½ to 3½ per cent. of lime (CaO) per weight of beets. Besides, the limecake fresh from the filterpresses contains about 50 per cent. of water, but as the latter rapidly evaporates, the composition will soon change. As an average, we may figure about 10 per cent. of the weight of beet in fresh limecake, the analysis of which is approximately as follows:—

	Per cent.
Water	50·0
Calcium Carbonate†	40·0
Organic Substances	5·0
Nitrogen	0·28
Phosphoric Acid	0·26
Potash	0·15

It is applied in large quantities, 12 to 25 tons to the acre being usual.

If we bear in mind what has been said of its action, and remember that Thomas slag and superphosphate also bring considerable quantities of lime into the soil, it will be evident to one that liming must not be practised every year.

In regard to the lime contents of soils, it may be added that soils containing in dry condition less than 0·25 per cent. of lime (CaO), equal to 0·45 per cent. carbonate of lime ($CaCO_3$), are considered in general *lacking in lime*. It is needless to add that there is no fear whatever that the use of limecake will introduce *nematode infection* into the farm.

As to the money value of these by-products, we find the pulp brings in about 2s. to 3s. per ton of fresh pressed pulp (100 lbs. beets give

* Especially potash combinations.

† Representing 22·4 per cent. lime (CaO).

about 60 lbs. of this pulp), though in different countries the different customs make this question of cost somewhat difficult to define. In France, for instance, the grower contracts to buy 40 per cent. of his delivered beet-weight at 2s. 5d. to 5s. 10d. per metric ton (2200 lbs.) In Germany a custom prevails whereby pulp amounting to 45 per cent. of the beet-weight is delivered gratis to the grower. Dry pulp cost in the 1907-08 season 4s. 7d. to 5s. per 110 lbs. at the factory. In Austria it is customary to deliver pulp 40 per cent. of beet-weight free of cost to the growers. The value of the wet pulp is about 3s. 4d. per metric ton, while dry pulp fetches about 70s. per metric ton. In Belgium most growers are obliged to buy 40 to 60 per cent. on weight of their delivered beets in pulp at prices varying from 4s. to 4s. 10d. per metric ton. In Holland pulp fetches about 4s. to 5s. per metric ton, of which sum 2s. 6d. represents freight paid by the factory.

In the United States pulp was at first regarded as a nuisance, as the farmers would not take to it. The writer remembers to have seen a specially hired and walled-in piece of land containing the pulp of a whole campaign rotting away. However, circumstances have changed during the last few years and the experiment stations have done their share towards making the farmers understand the value of this by-product. Some factories in that country which cannot readily dispose of their pulp keep large herds of cattle, which are fattened on the residue and then are sold at a profit by the Company. Drying installations have also been built by some companies with success in the States.

In Europe limecake is readily sold, bringing in 1s. to 2s. per metric ton. As to the earth from the settling basins, this is generally disposed of gratis.

The value of molasses depends on the possibility of selling this by-product to a distillery and on the market price of spirits. Only a small part of the total molasses production is used for cattle-food.

In the first chapter, we indicated the fundamental truths relating to the restoration to the soil of the amounts of plant food taken from it by a good crop of beets. In the series of by-products we have pointed to the cheapest and best way in which the growers can supply the want of lime in their soils, receiving in the same process small but easily available quantities of nitrogen, phosphoric acid and potash.

In regard to the other nutritive elements, we may point to the not inconsiderable quantity of cattle food produced (as will be remembered about 60 per cent. of pulp on weight of beets containing about 15 per cent. dry substance, and a varying quantity of leaves and heads) wherever beets are grown and worked up into sugar. Though the extensive use of artificial manure has made such tremendous strides in the last 20 years, and rightly so, we must remember that the useful effect of good stable manure should never be underrated. We

should look on it not only as a carrier of available quantities of plant food (varying within rather wide limits, depending on the animals that produced it, their food rations, the kind of litter used, and finally the care bestowed on the preservation of the chief constituent, the nitrogen), but also as the chief means farmers have in hand to ameliorate the physical condition of their soils. As we all know, it forms the *humus* which darkens the soil, thus giving it more power to absorb the sun's rays. Heavy clay soil will become looser in structure, and light soils will obtain more water-retaining power by its application. The fermentation in manure, leading to various stages of decomposition, is best kept within limits by having the manure piled up under cover in a manure pit with a stone bottom, which makes it possible to retain the liquid and occasionally pump it over the mass. Treading the manure down will also be effective. That well-known medium for retaining nitrogen, *common gypsum*, should not be forgotten. Layers of earth will serve also but not so well. In order to become available as plant food, the organic nitrogen substances in it must be nitrified. By the action of bacteria, moisture and warmth, the nitrogen is transformed into ammonia, which in turn is oxydized into nitric acid, which readily combines with the basic compositions into nitrates, which when the plant needs it, offer an available soluble plant food. That stable manure should therefore be applied in the fall, and ploughed under is a necessity that was dwelt on at the commencement of these articles.* Another natural manure, the urine from cattle may also be referred to. Very good results have been obtained by applying it by means of a special sprinkler (such as Clayton and Shuttleworth of Lincoln manufacture) between the young beet plants, the effect of its application being equal to that of Chili saltpetre.

It must be remembered that in stable manure the phosphoric acid is not present in relation to nitrogen, as the beet needs those two elements; it is therefore necessary to supplement it with artificial manures. Resort will therefore have to be had to these latter, as also in those cases where sufficient stable manure is not available, and, as already remarked, under the guidance of trained agriculturists a wise choice should be made, which of the long list of artificial fertilizers will at the smallest cost have the best effect, in short, will ensure the grower receiving the best financial return for his labour. In regard to supplying nitrogen, the farmers will have to choose, beside the application of green manure (the ploughing under of clover or other

* The reason why the application of stable manure used to be forbidden or restricted in the contracts was probably, that the farmers did not comply with this stipulation. When it is applied in the spring, the beet will have available nitrate nitrogen all through the summer. The beet will take to it, when it has no more need for it, and a beet with a high harmful nitrogen content, leaving a large molasses residue will be harvested. The same holds good when Chili is applied late and in unreasonably large quantities.

leguminosae, that possess the capacity of gathering nitrogen from the air) the employment of ammonia sulphate, Chili saltpetre, potash saltpetre, and the new nitrogen combinations, manufactured from lime and air-nitrogen by the aid of an electric current.

We do not propose to give results of Continental trials with these fertilizers, though extensive data are available. But a few words may be said here about the new nitrogen fertilizers. The method first indicated by Sir W. Crookes in 1898 of utilizing the air nitrogen has led to various manufacturing processes, which produce air-nitrogen by the aid of an electric current, in a form which can be shipped and finally sown as manure. So in Norway a lime saltpetre is made, containing 13 per cent. nitrogen. (The production in 1910 was 25,000 tons.) In Italy raw calcium carbide is heated in retorts, and calcium cyanamide is formed by leading nitrogen over the hot carbide, containing 20 per cent. nitrogen. (The production in 1910 was 70,000 tons.)

Mixing with earth is recommended as the fine powdery form renders it liable to be blown away; it should be finally harrowed under. Norwegian lime saltpetre and lime nitrogen do not stand mixing with ammonia sulphate, superphosphate, stable manure, guano, or bloodmeal. Chili saltpetre being entirely soluble in water, and the saltpetre not being retained by the soil, as already indicated, the application is divided into portions of which the saltpetre nitrogen is directly utilized by the young plants. Its action therefore should be regarded as a driving one; at the same time, however, the ripening period is postponed, which action may be counterbalanced to some extent by supplying phosphoric acid. Any postponement of the ripening, producing beets rich in non-sugar and not as rich in sugar as they should be when fully ripened, proves a nuisance in the crystallization processes and tends to augment the molasses percentage.

Clauses designed to forbid Chili heading in beet growing contracts were once customary. However, the high bred beet strains seem to stand Chili better than formerly, and when applied at the right time as is stated above, this prohibition is no longer justified; yet it will be better not to drive the nitrogen manuring too far. Chili saltpetre is apt to form crusts, which need an extra good hoeing to overcome.

Perchlorate of potash, poisonous to plants, should of course be absent. For such reasons, as well as for guaranteeing the percentages of the fertilizing elements, artificial manures—in fact all trade manures—should be prepared under control of State laboratories, and be sold as warranted by these Institutions.

(To be continued.)

BARBADOS.

EXPERIMENTS WITH SUGAR CANE, 1909-10.

The Report of the Department of Agriculture, Barbados, for the year 1909-10, has the following notes on the experiments with sugar cane, which were carried out under the supervision of Mr. J. R. Bovell.

"During the period under review, experiments were conducted on fifteen estates with the different varieties of canes obtained from seed grown in comparison with the White Transparent as a standard. Experiments were carried out in duplicate with the older varieties that have proved worthy of further cultivation at the various plantations. Single experiments with the older varieties and some newer varieties were carried out at Dodds, and several other estates which are representative of the various districts of the island. At Dodds most of the level cultivable land is occupied with seedlings in various stages of experimentation. On the fields of this estate the newest varieties are cultivated, and as any of them prove worthy of extended cultivation, they are taken to the various estates mentioned above, and grown under normal plantation conditions. If the results warrant it, the planters are then recommended to grow them in small areas, and gradually to increase the areas if the canes are found suited to the soil and climatic conditions of the district.

"In addition to these experiments, a series of experiments, which may be called co-operative ones, is carried on with the aid of the planters on various estates. In this series, the better variety of seedling canes is grown in plots of from a half-acre to two acres in comparison with the White Transparent, the standard cane. The canes from each variety are reaped separately and weighed in some instances; in the other cases where a weighing machine is not available, the juice is only expressed, the number of gallons ascertained and a sample analysed.

"In addition to the experiments with different varieties of sugar canes, experiments with chemical fertilizers have been carried on at Dodds, and, as in this instance the same manures have been applied to the same plots for some years, the results are valuable, and indicate the lines on which sugar canes in those portions of the island with similar soil and climatic conditions should be manured. In addition to these experiments with different chemical fertilizers, four series in duplicate were carried out, with sulphate of ammonia, nitrate of soda, and calcium cyanamide, on quarter-acre plots, at Dodds and Brighton in the black soils, and Blowers and Clifton Hall in the red soils. As the manurial experiments carried on at Dodds with the small experiment plots for the past sixteen years have so far shown on the average that the application of superphosphates is

unnecessary for sugar canes, Mr. E. L. Hollinsed, the attorney and manager of the Society and College estates, was good enough to apply nitrogen and potash to the halves of two fields of canes, and nitrogen, potash and superphosphate to the remaining halves of the same fields, so as to ascertain the results on large size plots in a different district. These canes on these two fields have just been reaped, and it may be mentioned here that the results confirm those obtained at Dodds. Another experiment of interest was undertaken by Dr. C. E. Gooding, and that was to ascertain what effect, if any, the 'cutting out of dead hearts' had on the yield of the canes. For some years the Superintendent of Agriculture had observed that the cutting out of 'mother plants' tended to reduce the yield, and in the past had carried out experiments which confirmed his observations and showed that where the canes were cut from a clump, the severed base was usually attacked by a fungus; he therefore thought it probable that the 'cutting out of dead hearts' might have an injurious effect on the growth of the canes, owing to the severed portions of the canes attached to the stool being attacked by a fungus. He had also observed that in the months of May and June it was usually difficult to obtain a batch of moth borer eggs that had not been parasitized by the parasitic *Trichogramma pretiosa*. Further, that when a young shoot was killed by the larva of the moth borer, the plant gradually shed the killed shoot in such a manner that the base of the shoot attached to the stool formed a layer of tissue impervious to fungus attacks. He therefore asked Dr. Gooding to cut out the 'dead hearts' from one half of a field, and to allow them to remain in the other half. This Dr. Gooding readily consented to do, and he divided a field of 4·26 acres into two equal portions. From the cut-out portion of the field, which was, if anything, the better half, 4·43 tons of sugar were obtained, while from the portion not cut out 5·07 tons were obtained, the loss from the cutting out of dead hearts being 0·3 ton of sugar per acre. Of course, as with all agricultural experiments, too much stress cannot be laid on the results of one year's work, so it is proposed, with the co-operation of other planters, to repeat the experiment on at least three other estates during the coming year.

"Towards the close of 1909 it was discovered that the root borer, *Diaprepes abbreviatus*, Linn., was attacking sugar canes in the south eastern portion of the parish of Christ Church Later on the larva of this insect was also found in the eastern half of the parish of St. Philip and one or two estates in the parishes of St. John, St. Michael, St. James and St. Lucy. These insects bore into, and eat away, the substance of the underground stems, tunnelling into the thicker portions, with the result that the cane dies. The general appearance of the stool is much the same as if it was being killed by the root fungus (*Marasmius sacchari*), or dying from drought. It may be

here mentioned that the Superintendent of Agriculture has not yet seen a clump of sugar canes attacked by the larva of *Diaprepes abbreviatus* in which *Marasmius sacchari* was not present, while he has seen a stool of sugar canes, as far as he could judge, free from the root fungus in a field in which a number of canes were attacked by the root fungus and root borer, while the stool free from the fungus was also free from the root borer. A number of experiments with carbon bisulphide for killing the grub were instituted, and so far the best results were obtained where a quarter of an ounce of carbon bisulphide was applied about two to three inches deep in holes made with an agricultural fork on the four sides of the stool, *i.e.*, one ounce per clump. The death rate in these instances was about eighty per cent. Where it was put deeper, or where less was used, the results were not as satisfactory. Where the canes were attacked by the root borer, the planters were advised to cut them as soon as possible and to dig up the stools, so that the birds and ants could destroy the larva, and then to stack the stools in heaps with unslaked lime, and to cover them with soil and allow them to remain until they are thoroughly decayed. They were also advised to rotate the field with such crops as cotton, cassava, yams, eddos, woolly pyrol and pigeon peas, as these are not attacked, or only slightly so, by this pest; and to avoid if possible, planting such crops as sweet potato, Indian and Guinea corn, which are known to be foot plants for the root borer."

THE VALUE OF MOLASSES AS A FERTILIZER.

By William E. Cross, Ph.D.,

Louisiana Sugar Experiment Station, New Orleans, U.S.A.

The article on Hawaiian waste molasses in the January number of this *Journal* emphasizes the necessity of finding some profitable way of disposing of molasses when the common methods, such as distillation, &c., are not available. The present position in this matter is well summed up by Prinsen Geerligs* when he says: "The question of how to utilize molasses in countries where the transport of molascuit, rum, &c., to other countries is too expensive is, therefore, still unsolved, and generally the only way of getting rid of this troublesome by-product is to throw it into the nearest stream."

The idea of using the molasses as a fertilizer has been suggested, and now and then results have been obtained, which were quite out of proportion to the amount of actual mineral matter in the molasses, the molasses being vaguely said to have "renovated" the soil. As large quantities of molasses are annually being thrown away as worthless, it is of the utmost importance for us to know whether it is a good fertilizer, and, if as ordinarily applied it is not, whether

* "Cane Sugar and its Manufacture."

methods of employment could be found by which it could be advantageously used.

With regard to the mineral element it contains, the fertilizing value of molasses is not high. In the first place, the total ash content usually runs to between 6-10 per cent., and of this only about one half is of any fertilizing value, as the following analyses of Louisiana molasses show:—

Composition of Ash from Different Molasses.*

	I. Mill Sulphitation. Per cent.	II. Diffusion Sulphitation. Per cent.	III. Open Kettle. Per cent.	IV. Carbonatation. Per cent.
Potash K_2O	49·48	52·20	51·48	50·16
Soda Na_2O	0·89	0·80	1·11	0·32
Lime CaO	6·47	6·78	6·58	8·53
Magnesia MgO	4·29	3·09	3·99	2·66
Iron Oxide Fe_2O_3	0·35	0·33	0·15	0·47
Alumina Al_2O_3	0·30	0·22	0·13	0·30
Silica SiO_2	4·12	4·59	2·83	4·10
Phosphoric Acid P_2O_5	3·71	3·80	2·12	0·91
Sulphuric Acid SO_3	10·79	6·72	10·94	11·18
Carbonic Acid CO_2	7·49	11·19	13·06	15·78
Chlorine Cl	14·00	11·95	9·10	4·59
Total	101·89	101·67	101·49	99·00
Deduct O — Cl	3·16	2·70	2·05	1·04
	98·73	98·97	99·44	97·96
Undetermined (Carbon, &c.)	1·27	1·03	0·56	2·04
Alkalinity (c.c. $\frac{N}{10}$ per gr. Ash)	80 c.c.	93 c.c.	95 c.c.	109 c.c.

The Hawaiian molasses† are similarly low in content of valuable mineral substances:—

No.	Silica.	Iron and Alumina.	Lime.	Magnesia.	Potash.	Soda.	Sulphuric Anhydride.	Phosphoric Anhydride.	Chlorine.	Carbon Dioxide (in Ash).
1	·020	—	1·309	·768	2·430	·121	1·001	·242	1·226	1·502
2	·103	·158	1·826	·986	1·216	·116	1·116	·158	·644	2·116
26	·349	·188	2·458	·795	1·666	·164	1·507	·221	·925	1·975
3	·175	·389	1·095	1·172	3·481	·106	1·807	·388	2·137	1·683
9	·198	·327	1·090	1·016	3·551	·226	1·761	·401	1·983	1·239
16	·110	·174	1·344	·701	3·432	·214	1·242	·161	2·030	1·702

* Bulletin 91, Louisiana. † Bulletin 18, Hawaiian Sugar Exp. Sta.

Nitrogen is also found only in small percentage; 0·5 per cent. is probably an average for Louisiana. How much of this is available can be seen from the following nitrogen analyses of a typical molasses:—

DISTRIBUTION OF NITROGEN IN LOUISIANA MOLASSES.

	Percentage in Molasses.		Percentage of Total Nitrogen.
Nitrogen in Albumoses and peptones ..	0·0153	..	3·28
Nitrogen in amido-acids	0·1774	..	38 00
Nitrogen in amido-acid amids..	0·0672	..	14·38
Nitrogen in ammonia	0·0147	..	3·15
Nitrogen in nitrates	0·0370	..	7·92
Nitrogen in nitrogenous bases (xanthin, &c.)	0·1113	..	23·83
Nitrogen in other forms	0·0441	..	9·44
Total	0·4670		100·00

From this it would appear that (leaving out the 9·44 per cent. nitrogen in other forms) only about 65 per cent. of the nitrogen would be quickly available, the rest requiring a more or less long period of time in the soil before being available by the plant.

In spite of this poorness in valuable plant elements, molasses has been shown to "renovate" soil, sometimes in a remarkable degree, and Sedgwick ascribes this renovation to a "fermentation of the molasses," and also showed that in his experiments certain other organic substances "renovated" the soil in a similar way. Certain other experiments on the effect of carbohydrates on soils have given results in keeping with these, and show that besides renovating the soil, the carbohydrates actually produce indirectly an increase of the nitrogen content. It is known that one way of increasing the nitrogen content of the soil is by bacterial action. The well-known enrichment of the soil by leguminous plants for example is due to certain bacteria, *e.g.*, *Bacillus raditicola*, which assimilate nitrogen when living in symbosis with the leguminous plant itself. But besides this, a soil which is lying fallow, although no leguminous plants are present, has also been shown to accumulate nitrogen. For instance, Berthelot showed, in one experiment, that the results of allowing a well äerated soil to lie fallow for seven months was an increase of ·024 per cent. nitrogen. This accumulation of nitrogen has been much studied during recent years, and it has been definitely proved to be due to certain bacteria in the soil, *Clostridium pasteurianum* and the various *azotobacter* species, which form an exception to nearly all other forms of plant life in possessing the power to absorb nitrogen directly from the air. Moreover these bacteria require organic substances, especially carbohydrates, to sustain life, and it has been shown that if the amount of carbohydrates available to these bacteria is increased, an increase in their activity follows. This is the now generally accepted reason why a growth of *algae* brings about an accumulation of nitrogen in soils: the *algae* by virtue of their chlorophyll assimilate carbon dioxide,

producing carbohydrates, which latter are partially at the disposition of the *azotobacter*, which therefore show increased growth, and higher activity in respect of nitrogen accumulation.

The activity of these nitrogen-assimilating bacteria is also enhanced by the addition of soluble carbohydrates to the soil. This can be easily shown by the following experiment. Two plates, each containing 500 grms. of soil, kept in a fairly moist condition, are allowed to stand in a warm room (about 33°C.) for three weeks (until the sugar is all used up). The soil on one of the plates is treated with a solution of 20 grms. cane sugar before the experiment; to the other plate no addition of sugar is made. The nitrogen content of the soil in each plate is determined before and after each experiment. It will be found that the soil which has been treated with sugar has gained in nitrogen, indeed the gain is in proportion with the amount of sugar, 2-6 mgrms. nitrogen for each grm. of sugar used up being about the usual increase. Similar experiments to this have been carried out by many investigators, including Berthelot, Winsgradsky, A. Koch, and others, with similar results. While, so far as we are aware, such experiments have not actually been performed with molasses, still it is practically certain that the sugar contained therein would have the same effect.

It is therefore not difficult to understand why the soil "renovation" was produced by the application of molasses as a fertilizer. The molasses furnished carbohydrates to the nitrogen-assimilating bacteria, which in consequence became more numerous and more active, assimilating nitrogen in proportion to the amount of sugar added. Had the nitrogen content of the soil before and after the experiment been determined, it is very probable that an appreciable increase would have been found, bringing the experiment in line with the experiments on the effects of treating soil with sugar by Berthelot, Koch, and others, above mentioned.*

We are ourselves undertaking such experiments with molasses and soil which are to include the control of the nitrogen content of the soil; but it would be well that other experiments of a similar nature should be carried out at other places as well, where the soils and conditions generally are quite different from ours. †

It is interesting to calculate the value of molasses as a fertilizer if the sugar in it produced, as it has been shown to produce in experiments, an average of three mgrms. nitrogen assimilated per grm. sugar used. Reckoning the total carbohydrates of the fifteen million

* The sugar is partially converted by the *clostridium* and other bacteria into acids, mainly butyric: hence the necessity of sufficient lime being present to neutralize this acid, as Sedgwick mentions.

† Since this article was sent for publication, the author has seen a copy of the Hawaiian Bulletin No. 34 entitled "Some Biochemical Investigations of Hawaiian Soils," in which some experiments of this nature are described.

gallons (*i.e.*, about 180,000,000 pounds) Hawaiian molasses as 50 per cent., we get as the quantity of nitrogen assimilated through its use as a fertilizer (if the bacterial action is the same as in the small experiments) 270,000 pounds nitrogen, which in the form of Chili saltpetre would cost about $43,000 (£8600).

It might thus appear, from the beneficial "renovative" effects which have been described as resulting from fertilizing the soil with molasses, and from the fact that these results are, as has been shown, in keeping with modern bacteriological science,—that molasses might unhesitatingly be recommended as a fertilizer. Such a recommendation would, however, be premature, for although the treatment of soil with sugar will in every case (in presence of sufficient lime) bring about an increase in the activity of the *azotobacter*, &c., and in the amount of nitrogen absorbed, the sugar may under certain conditions have evil effects which may sometimes be so serious as to negative entirely the benefits of stimulating the *azotobacter*. Besides having an injurious effect on the growth of many plants, sugar in a soil also, under certain conditions, stimulates the action of certain other bacteria, the *denitrifying* bacteria, which *remove* the nitrogen found in the soil in the form of nitrates, and either set it free as free nitrogen (which passes off into the atmosphere) or convert it into complex nitrogenous substances, which are only available to plants after a long period of weathering. So that if we mean to apply sugar or molasses as a fertilizer, we must take care to avoid those conditions under which denitrification takes place.

The question as to exactly what conditions determine the loss of nitrogen by denitrification has given rise to much discussion, and to what extent denitrification takes place in ordinary soils is still a debated matter. The preponderance of evidence, however, goes to show that under ordinary conditions denitrification takes place only to a very small extent, and furthermore that the conditions which must be fulfilled before denitrification can take place are (1) presence of nitrates, (2) badly äerated soil, (3) presence of a large quantity of carbohydrates in the soil. For example, the use of stable manure (which is rich in carbohydrates) and Chili saltpetre together for fertilizing purposes would mean the loss of most of the saltpetre employed, which loss would be brought about by the action of the denitrifying bacteria.

Thus it is seen that the possibility of denitrification taking place adds a new factor to the question of fertilization with molasses. It can hardly be said that this possibility would entirely prevent the method becoming a successful one, but on the other hand we must take care that the conditions are as unsuited to the denitrifying bacteria as possible. From what is now known, it would seem that a well tilled soil might be treated with molasses with great advantage in increasing the nitrogen content of the soil. In this way the

anäerobic denitrification process would have little chance of establishing itself before the sugar in the molasses was used up.

However, the only method of determining accurately the conditions under which the molasses best "renovates" and increases the nitrogen content of the soil is the experimental one. That such conditions exist is shown by the experiments already reported, where the "renovating" power of the molasses was discovered; tests are needed however to determine the conditions of *maximum* renovation, which will be, as has been shown, the conditions of maximum activity for the azotobacter and other nitrogen-assimilating bacteria, and minimum activity for those of the denitrifying type.

RUSSIAN SUGAR NOTES.

The Russian sugar position since the 1910-1911 campaign opened with the beginning of September has developed no feature that could not have been easily anticipated by a superficial observation of the various elements that go to make up the sugar situation in the country as they were to be found at the beginning of the campaign. The abundant beet harvest (which for a time it appeared might be rather poor relatively to its size because of the reduced quantity of sugar naturally consequent on the wet weather, which had induced an extraordinary growth of the roots) benefited at the finish by some weeks of fine weather with the result that a much larger proportion of sugar content was harvested than had been expected.

This joined to the Government measures taken to reduce the cost of sugar on the inland market, which had been exaggerated by speculative manufacturers at Kieff and Moscow, had the effect of reducing the price of the article all the country over and putting the speculators into very grave difficulties. Futhermore, the pressure of the great beet harvest and the consequent prospects of a large production of sugar in the current campaign has been such as to keep the prices low ever since; and, although the sugar refiners had met together and agreed to form a new syndicate and had resolved on certain minimum prices to be observed, the market refused to respond to their desires and pressure, and it continued weak. But on March 14th when they met again they determined that the only way to relieve the market was to take a large quantity of sugar off it. Having so determined, the meeting, which was attended by some sixty representatives of refineries, unanimously agreed that 10 per cent. of the production should go into the reserve and thus reduce the market to a normal condition and enable the refiners to have a little bit of their own way.

This practically sums up the sugar situation in Russia since early September. The production, unless arbitrarily interfered with, will be a record one and no doubt there will be a large surplus for export which will have its effect on the foreign market.

The reports of a number of sugar refineries have appeared for the past year during the season of the Kieff contract market; and the reports that have been published speak unanimously of a very successful year; handsome dividends being declared. This does not mean that such dividends will be declared in the case of companies whose meetings or reports have yet to be published, but up to date everything looks well; and it is expected that the reports to come will be likewise favourable.

In view of the foregoing it is very easy to understand that existing companies are making arrangements for extending their factories to deal with, in the first place, the large quantity of beetroot at their disposition, and in the second place to take advantage of the ever-growing Russian market. It must be remembered that the Russian population increases very rapidly and that the sugar production has to increase at the rate of about 3 per cent. per annum to keep pace with it; and when it is further considered that the economic position of Russia improves daily, particularly when supported by fine grain harvests, it will be seen that the demand for sugar would naturally grow at an even greater rate than the population itself. Foreseeing this, both crude producers and refiners have taken the necessary steps to extend their works and have given orders to machinery builders for this purpose.

Furthermore, some old factories that had lain idle are being re-opened and new factories are being built, so that the world has to anticipate a largely increased Russian sugar production probably at a greater rate even than required by the country; for each manufacturer will desire to produce to meet the consumption to the fullest extent of his power. The Russian industry, therefore, stimulated by the past fine business year and the abundant raw material and the no doubt increased area that will be sown with beetroot in the current year, will become a feature in the sugar industry and trade of the world, such as it had hardly threatened to become at any previous period.

There is not much to report regarding the Far East. The factories in existence there are producing a fairly good quality of sugar, one in particular near Harbin, which is under Russo-Chinese control.

The Germans, too, are seeking to have a hand in the Far Eastern sugar industry, and it is said will build, or are already building, extensive sugar mills in Manchuria to get a share of the local trade.

It is known well enough that the Russian sugar business with Persia is an important one, and one of which the country is very

jealous; but it is not so well known that serious steps have been taken to plant Russian sugar firmly on the Turkish market. The following statement will afford information of a very interesting nature on this point. It is taken from a review of the sugar market in Turkey, in 1910, in which the Russian Consul in Constantinople says that sugar constitutes one of the principal articles of consumption and importation into Turkey and is delivered there chiefly by Austria. Austrian sugar is not distinguish by its high quality but, nevertheless, its producers have succeeded in getting a firm position on the Eastern markets.

From Austria there are imported into Turkey three kinds of sugar:—broken, which consists of lumps of 4-12 kg., conical and irregular in form, and also of large well-crystallized strong and non-friable lumps; second, granulated or crystallized white, always supplied in double bags of 100 to 102·65 kg.; and third, Dutch form, in square lumps pretty regular in form, white crystallized.

In 1910 the quantity imported of the first category amounted to 26,000 tons, valued at 10,500,000 kronen; of the second category, 23,000 tons valued at 8,500,000 kronen: and of the third category, 4500 tons valued at about 2 000,000 kronen.

Respecting the efforts Russia is making to get a market there, he states that from the beginning of October last year the export of Russian sugar to Turkey was renewed, and began to grow; and for that period the importation of Russian sugar into Constantinople amounted to 256 waggons or 35,328 sacks weighing 229,632 poods net of Russian sand sugar, making an average of about 85 waggons of 900 poods each. The Austrian waggon, it appears, carries only 615 poods. (It may be mentioned here that Russian railways have been giving considerable attention of recent years to the high capacity goods waggon.)

He does not fail to say a word on behalf of the national sugar and adds that in view of the fine quality of Russian sugar the buyers readily give it a preference over the Austrian on equal terms; consequently, Russian sugar will succeed in forcing the Austrian off the market. Unfortunately, we must remember that Russian sugar reaches Turkey in bags made of material which is not distinguished for its strength. The bags are not sewn with sufficient care and in consequence of this the sugar arrives at its destination in a condition far from irreproachable.

THE GREEN MUSCARDINE OF SUGAR CANE FROGHOPPERS.

By James Birch Rorer,
Mycologist, Board of Agriculture, Trinidad.*

Although blight has been known as a specific disease in Trinidad cane fields for the past 30 years or more and many planters have always maintained that the froghopper (*Tomaspis postica*) was responsible for the trouble, there has been much doubt expressed as to its cause by those who have investigated the outbreaks until within the last year, the uncertainty that has existed being well summed up in the following concluding words of the report of the chairman of the committee which was appointed by the Agricultural Society in the latter part of 1908 to collect evidence from cane planters as to the cause of blight: "The primary cause in my opinion being root fungus or boring insects, or unfavourable soil and climatic conditions, or a combination of these, leading to the formation of different kinds of fungi known to attack canes."†

However, from studies which have been made both in the field and in the laboratory during the past year there seems now to be but little doubt that the froghopper is the cause of blight, and the question of getting rid of blight has resolved itself into the question of destroying the froghopper, or at least of reducing its numbers to a negligible quantity.

Naturally the problem is an entomological one, and both Mr. Urich, Entomologist of the Board of Agriculture, and Dr. Gough are investigating the disease from that point of view and doubtless they will publish full reports in due time. From the mycological standpoint the only interest in the disease is to ascertain whether or not plants which are attacked by fungus diseases are more subject to the attack of the froghopper, and whether the insect can be controlled by wholesale inoculation with spores of the fungus which causes green muscardine, a disease to which the froghopper is very susceptible.

History of the Fungus in Trinidad.

So far as the writer knows, Hart ‡ in 1890 was the first to observe that the adult froghoppers in Trinidad cane fields were attacked at times by a fungus, which he considered one of their natural enemies. The next mention of this fungus was in 1906 by Urich § who stated

* Abridged from *Proceedings of the Agricultural Society of Trinidad.*

† 1909,—Carmody, P. To the Members of the Cane Blight Committee. Proceedings of the Agricultural Society of Trinidad and Tobago. 9 : 107.

‡ 1890.—Hart, J. H. Report on sugar cane blight. Agricultural Record of Trinidad. 2 : 127. Reprinted in Bulletin of Miscellaneous Information, Botanical Department, Trinidad. 7 : 153. October, 1906.

§ 1906.—Urich, F. W. Froghoppers. The Mirror, Port of Spain, Trinidad, September 19.

that on Orange Grove Estate a large percentage of the insects was being killed by a fungus, and in this way the brunt of the attack of blight seemed to have been checked. Later in the same year Hart * again mentioned the fungus and stated that it undoubtedly hastened the disappearance of the froghoppers.

Two years later Collens† found that froghopper nymphs confined in a breeding chamber together with perfect insects covered with the fungus became infected and died before reaching maturity, and later became covered with spores.

The writer ‡ found the fungus in abundance during the past two rainy seasons especially in the months of August and September and began cultivating it artificially early in 1910, and published a brief report a few months ago.

The fungus is well distributed over Trinidad and is always found in any cane piece in which froghoppers abound; at times two or three dead insects may be found on the same cane plant, or even on the same leaf. The adult insects killed by the fungus do not fall to the ground but are found attached to the balas portion of the upper leaves.

As the writer ‡ has previously stated a great deal of confusion has existed here as to the identity of this fungus. Hart* and Collens † considered that it belonged to the Entomophthoraceæ, while the material sent to the United States Department of Agriculture was determined as *Oospora destructor* or *Penicillium anisopliæ*,§ and that sent to Kew as *Septocylindrium suspectum*, a new species. ||

A cursory examination of the fungus shows that it is neither an Entomophthora nor a Septocylindrium. Specimens and cultures were sent by the writer to Dr. Roland Thaxter of Harvard University who determined the fungus as *Metarrhizium anisopliæ* Sorokin. *Entomophthora anisopliæ* Metschnikoff, *Isaria destructor* Metschnikoff, *Oospora destructor* (Metschni.) Delacroix, and *Penicillium anisopliæ* (Metschni.) Vuillemin are all synomyms. The fungus is of wide distribution and attacks a variety of insects of different orders and in different stages of development. A number of papers dealing with the fungus have appeared from time to time since 1878 in the mycological journals of Russia and France.

Metschnikoff ¶ was the first to discover this fungus on the larvæ of *Anisoplia austriaca*, the cockchafer of wheat in Russia.

---

*1906.—Hart, J. H. Cane diseases. Bulletin Miscellaneous Information, Botanical Department Trinidad. 7 : 153.

†1908.—Collens, A. E. Sugar cane blight and the froghopper. Proceedings of the Agricultural Society of Trinidad and Tobago. 8 : 152.

‡1910.—Rorer, J. B. The froghopper fungus. Report to the Board of Agriculture, Trinidad. Issued September 25.

§1909.—Bulletin Agricultural Information. Trinidad, 8 : 45.

||1910.—Bulletin Miscellaneous Information, Royal Gardens, Kew. No. 1, p. 4.

¶1879.—Metchnikoff, E. Zeitschrift der Kaiserlichen Landwirth Gesellschaft für Neurussland, Odessa, pp. 21-50, with plate.

He gave it the name *Entomophthora anisopliæ* and called the disease which it produced *la muscardine verte*. In the same year Sorokin* studied the fungus and concluded that it was not an Entomophthora and gave it the new name of *Metarrhizium anisopliæ*. A little later Metschnikoff † again studied the fungus and concluded that it belonged to the genus Isaria and gave it still another name, *I. destructor*. The same fungus was found in France in 1893 on silk worms, and specimens were examined by Delacroix ‡ who concluded that it belonged to the genus Oospora and so called it *O. destructor*. *Penicillium anisopliæ*, still another name, was given to the fungus by Vuillemin. §

A variety of the fungus which attacks the larvæ of Agriotis has been described from the United States by Pettit. ‖

From the above brief history it will be seen that though the fungus has been known and studied for a long time, its systematic position is quite uncertain, and will probably remain so until some other type of spore formation is found. For some time past the writer has been studying the fungus and growing it under varying conditions to see if a perfect form of spore production could not be obtained but so far these efforts have been in vain. It seems quite certain that the fungus is not an Oospora nor a Penicillium, and probably not an Isaria, though in some culture media it takes on a more or less tree-like growth, characteristic of that genus. As it cannot be left in the genus Entomophthora, where it was first placed, perhaps it would be better to call it *Metarrhizium anisopliæ* (Metschni.) Sorokin, and consider it the type of that genus, which was created especially for this fungus, as its characteristics are not those of any other described genus.

Cultures of the Fungus.

Soon after discovering the fungus in 1878 Metschnikoff made pure cultures on beer mash gelatine and since that time it has been grown by a number of mycologists on a great variety of culture media.

The writer has experienced no difficulty in getting pure cultures by the ordinary poured plate method using potato agar as a medium. The fungus has been grown on various media, such as sweet and white potato cylinders, rice, beans, potato agar, horse dung agar, &c.

---

*1879.—Sorokin, N. Zeitschrift der Kaiserlichen Landwirth Gesellschaft für Neurussland, Odessa, p. 268.

† 1886.—Metschnikoff, E. Für Lehre über Insectenkrankheiten. Zoologischer Anzeiger. 3: 44-47. Abstract by C. V. Riley in American Entomologist 3: 103. 1880.

‡ Delacroix, G. *Oospora destructor*, champignon produisant sur les insectes la muscardine verte. Bulletin de la Société mycologique de France. 9: 260-268. Pl. XVI., Fig. 11.

§ 1904.—Vuillemin, P. Les Isaria du genre Pencillium. Bulletin de la Société mycologique de France. 20: 214-221. XI., Figs. 1-8.

‖ Pettit, R. H. Entomogenous Fungi. Bulletin 97. Cornell University Experiment Station, p. 356. Plate V.

It grows well on all these but makes the most luxurious growth on starchy substrata such as white potato cylinders and rice. When sown in potato agar the spores germinate in 4 to 6 hours, generally with one, but at times two, germ tubes near the ends. The hyphæ soon branch and become septate. Within a week spore formation begins and continues for a long time, the mycelium spreading over the surface of the media and at times growing up the sides of the tubes or flasks. The sporophores are grouped together forming short stalks and the spores are cut off from the ends of the hyphæ in long chains which adhere together in cylindrical, tube-like, or at times slightly fan-shaped, masses. The individual sporophores are simple, branched slightly, or even in a verticillate fashion, at times resembling those of *Penicillium*.

The prismatic masses of spores adhering together in fast circles are often 2 to 3 mm. in length and are olive green in colour. The individual spores are cylindrical, rounded at the ends and measure 6-9 $\times$ 2-3 μ. Spores are formed much more quickly in cultures which are kept in the light than those kept in the dark. The mycelium at times assumes a yellowish colour especially on sweet potato cylinders.

On insects the fungus has much the same appearance as in cultures. It attacks not only the adults but the nymphs as well. Spores which fall in the spittle surrounding the latter germinate there and the hyphæ soon penetrate the soft body. On the perfect insects the necessary moisture for spore germination is furnished by rain or dew. When once within the insect the mycelium grows very rapidly and fills up the whole body cavity, thus killing the host. As soon as the insect is dead the mycelium comes to the outside in small white tufts through the thin spaces between the body segments. These mycelial masses soon become confluent, spore formation begins, and eventually the whole insect is covered with a green powder. The attacked insects do not fall to the ground, but as a rule are fastened to the basal parts of the cane leaves by the mycelium of the fungus. This is undoubtedly of great advantage for the spread of fungus as the spores can reach other insects by contact and by wind dispersal from such a vantage point much better than if the diseased insects fell to the ground, though Collens* has expressed the adverse view. It is characteristic of a number of entomogenous fungi to force their hosts just before death to a high position and attach them there so that a good situation for spore distribution is obtained.

The Use of Fungus as a Means of Insect Control.

In 1880 Metschnikoff† suggested the possibility of using the fungus as a means of combating the cockchafer of wheat (*Anisoplia austriaca*).

*1908.—Collens, A. E. Sugar cane blight and the froghopper. Proceedings of the Agricultural Society of Trinidad and Tobago. 8: 152.

† 1886.—Metschnikoff, E. Für Lehre über Insectenkrankheiten. Zoologischer Anzeiger, 3: 44-47. Abstract by C.V. Riley in American Entomologist, 3: 103. 1880.

He obtained quantities of spores for inoculation purposes from the rich mycelium which developed when insects that had died from the green muscardine were buried in wet sand and kept there for a few weeks.

Another of the early attempts to use the fungus economically curiously enough was for the destruction of *Cleonus punctiventris*, a curculio which attacks sugar beets. In 1884 Krassilstschik* made trials with the fungus and stated that, by spreading the spores on the ground over infested areas, within 10 to 12 days he found from 50 per cent. to 80 per cent. of insects infected.

These early experiments, however, were not carried very far, evidently on account of the difficulty of getting spores in sufficiently large quantities, but the question of the possibility of using the fungus has been discussed from time to time in recent years by a number of Russian scientists, among whom may be mentioned Vilbouchewitch, Lindeman and Kalitaeff, the last being a strong partisan in favour of the use of the fungus. As yet however sufficient trials have not been made.

During the past four months the writer has carried on a number of inoculation experiments with the fungus on both adult and nymph froghoppers. The spores for these inoculations were obtained from pure cultures made in tubes and flasks on sterilized potato or rice.

On August 4th, 1910, fifty adult froghoppers were caught by hand and put into a cage about one foot high by one foot and a half square, made of wire mosquito netting and placed over growing grass in a cane trace. Twenty cubic c.m. of water was poured into a tube containing a fruiting culture of the fungus. By shaking the tube vigorously the spores were wetted and became suspended in the water. This liquid was then sprayed through the netting of the cage containing the froghoppers with a small atomizer. The cage was removed on August 9th, five days after the inoculation was made. During this period the weather was very favourable for the growth of the fungus, as gentle rains fell every day. The results of the inoculation were even better than had been hoped for. Not a single live insect was found, and though the ants had carried off many of the dead ones, 19 were found well covered with the fungus. There can be scarcely any doubt that practically all of the insects died as a result of the inoculation rather than from a natural infection, for at this time it was difficult to find diseased insects in the field in which the experimental froghoppers were caught. Again the cage was placed over the same patch of grass and new froghoppers introduced from time to time, but no more spores were applied.

---

*1886.—Krassilstchik, J. De insectorum morbis qui fungis parasiticis efficiuntur. Memoires de la Société des Naturalistes de la Nouvellerussie. Odessa. Vol. XI. fas. 1, pp. 75-172. Reviewed by A. Giard in Bulletin scientifique de France et de Belgique. Vol. 2, Series 3. 1889.

Many became infected, but owing to the fact that the ants carried them away as soon as dead, it was impossible to get any accurate record of percentage of deaths due to the fungus. At about the same time a large number of young nymphs surrounded by spittle were collected from cane roots and placed in moist chambers containing sections of cane which had been rooted in moist sawdust. After a few hours, when the nymphs had established themselves on the cane roots, spores of the fungus were blown from a pure culture into the moist chambers which were kept in a dark place. Forty-eight hours after inoculation it could be seen that the fungus was taking effect, for some of the nymphs were no longer involved in spittle and could scarcely crawl about. By the sixth day 90 per cent. of the nymphs were dead and the fungus was beginning to fruit on those which had died first. From one hundred inoculated nymphs only three adult insects were obtained and one of these died soon after emerging, while from nymphs which were not inoculated but kept in dark moist chambers with cane roots, 90 per cent. perfect insects were bred out. Similar experiments have been repeated a number of times. That the disease is very infectious is again shown by the fact that healthy froghoppers soon become diseased if they are collected in boxes in which diseased insects have been previously gathered. Mr. Urich has found it necessary at times to sterilize all his froghopper collecting boxes, in order to bring in healthy insects for breeding purposes. The fungus attacks not only the cane froghopper, but other species of *Tomaspis* as well.

The only experiment in which the fungus has been used in the open field was briefly reported in a previous paper.* About two ounces of flour was poured into each of six flasks containing one month old cultures of the fungus. The flasks were then shaken so that the spores became thoroughly mixed with the flour. This mixture of flour and spores from the six flasks was dusted over one hundred cane plants in a field where froghoppers were abundant.

Despite the fact that immediately after the spores were scattered there was a very heavy downpour of rain which must have washed many of them away, the effect of the inoculation could be seen after a week's time. Although insects attacked by the fungus were found on the surrounding canes fully 50 per cent. more dead ones were found in the inoculated area. These experiments leave no doubt that the fungus is capable of killing large numbers of froghoppers.

The problem yet to be solved is whether or not the fungus can be used on a larger scale under ordinary estate conditions.

In order to get spores in sufficiently large quantities for practical field inoculation some methods other than those in every-day laboratory practice must be used for growing the fungus. The writer has

*1910.—Rorer, J. B. The froghopper fungus. Report to the Board of Agriculture, Trinidad. Issued September 25.

designed what may be called a culture cabinet in which the fungus has been grown in quantity with almost no impurities. This cabinet may be considered as the unit and an indefinite number may be arranged in series. The cabinet is nothing more or less than a cupboard 6 ft. high, 2 ft. deep, and 3 ft. wide, the top, bottom, two sides, and the back, made of galvanized iron and the joints soldered. The front is a tight fitting door, with two glass panes for the admission of light. Eleven galvanized iron shelves are arranged horizontally inside the cabinet at intervals of 6 inches, and supported by brackets soldered to the side walls. Sets of two holes each, about half an inch in diameter, are punched through the back of the cabinet, midway between the top and the first shelf and each succeeding pair of shelves. These holes are plugged with cotton. The medium used for growing the fungus is boiled rice. The rice should be thoroughly washed and then put into boiling water and cooked for not more than ten minutes. It must not be pasty. This cooking sterilizes the rice and can be done in a large open pan or kettle. As soon as cooked, the rice should be dipped from the water with a perforated ladle or strainer and quickly spread in a thin even layer on all the shelves and bottom of the cabinet. The door is then closed. The heat from the rice in a way sterilizes the whole cabinet. After about two hours, or when the rice has cooled down enough, the inoculation may be made. Spores from one or two pure tube cultures are mixed with an ounce of flour, which has been sterilized in a dry oven, and placed in a clean insect gun or bellows, such as is used for blowing pyrethrum powder into cracks and crevices. The cotton plugs are removed from the holes in the back of the cabinet, the end of the bellows tube inserted, and the mixture of spores and flour blown into the cabinet through each hole in turn. The cotton plugs are then replaced. The spores germinate quickly in the rice and being present in large quantities thousands of colonies start all over the surface. Within a few days the whole medium is covered with a dense mycelium. Spore formation soon begins and at the end of three or four weeks the maximum number of spores has been produced. A few colonies of *Sterigmatocystis* or of *Aspergillus* may come up here and there on the shelves but they do no particular harm and cannot gain a foothold, on account of the predominance of *Metarrhizium*.

Perhaps the best method of collecting the ripe spores has not yet been obtained. However, they can be gathered fairly well by brushing them off or by the use of a vacuum cleaner or ordinary suction pump. Another method is to remove the shelves from the cabinet when the fungus is well fruited, let the medium dry and then shake the spores off through a fine sieve.

There are a number of different ways in which it is possible to use the spores in the field. The only method which has been tried thus far is the dusting of the spores over the cane tops. This dusting can

be easily done over large areas with a dusting machine, such as is used for distributing various insecticides and fungicides in dry form. A machine of this kind would blow forth a cloud of spores which would be carried over the fields by the wind and many would gradually settle down on the leaf axils, a favourite hiding place of the frog-hoppers, and thus be in a position to infect the insects. Then, too, as the eggs are laid in the leaves, the young nymphs as they hatch and crawl down the stem to the ground might also become infected.

Another method by which a green muscardine epidemic might be brought about is by catching the insects at night with lights, (as many as 5000 have been caught with a single lantern in a night) inoculating them and setting them free in the morning. A large percentage of these insects would contract the disease and die within a few days. The fungus would begin to fruit on the dead bodies, and the spores in turn would serve as a source of infection to others, for as previously stated the insects usually die attached to the basal parts of the leaves, the favourite hiding place for the insects in the day time. If a systematic campaign of this kind were started just after crop time on an estate there is no doubt in the writer's mind but that the frog-hoppers could be kept under control.

The most essential point in favour of the use of the fungus being successful is the fact that the froghoppers are more active during the rainy season, the time most favourable for the growth of fungus.

DETERMINATION OF SUCROSE IN CANE MOLASSES: USE OF HYDROCHLORIC ACID AND UREA FOR THE DIRECT POLARIZATION.

By H. PELLET.

For some time past the analysis of beetroot molasses has again been occupying attention, the object being to obtain a liquid which before inversion has the same acidity as after inversion, so as to have a difference in rotation due only to hydrolysed sucrose.

It is especially to Dr. Andrlik that we owe the solution of the problem in the use of a mixture of hydrochloric acid and urea.

A solution containing 5 grms. of urea and 5 c.c. of concentrated hydrochloric acid (sp. gr. 1·188) in 10 c.c. is prepared. To 50 c.c. of the liquid under examination, 10 c.c. of the hydrochloric acid and urea mixture are added, and the volume completed to 100 c.c. Then the liquid is filtered, if necessary, and polarized, the temperature of the liquid being observed. After this another 50 c.c. of the liquid being examined are placed in a 100 c.c. flask, 5 c.c. of concentrated hydrochloric acid (without urea) and 25 c.c. of water added, and inversion effected according to the Herzfeld procedure, the volume being completed to 100 c.c., and the liquid being polarized at the same temperature as before.

In calculating the sucrose per 100 c.c. the constant should be determined, if special accuracy be desired, and this is done by preparing a sugar solution of the same sugar content as the liquid being examined. In this way the true sucrose content is obtained.

The non-sugar substances polarizing more or less to the right or left in presence of basic lead acetate acquire a fixed rotation on the addition of the hydrochloric acid and urea mixture, which rotation is not modified during inversion. It is necessary to take the reading of the solution containing the hydrochloric acid and urea rapidly in order to avoid inversion, which, according to the temperature, may commence after about 7 minutes.

We have shown that sulphurous acid acts in the same way as the mixture of hydrochloric acid and urea does. Twenty years ago we advocated the use of sulphurous acid, especially for the purpose of precipitating the excess of lead in the form of lead sulphite, and of having all the free acidity for inversion as hydrochloric acid. But we did not know its action on the different products such as glutamine, glutamic acid, aspartic acid, &c.

It has now been demonstrated by the researches of Andrlik, referred to above, that sulphurous acid in sufficient amount has practically the same action as hydrochloric, which explains why our sulphurous acid process yields the same results as when hydrochloric acid and urea are used. In a remarkable study on the analysis of beet products by the aid of invertase, J. P. Ogilvie shows (this *Jl.*, 1911, 145-153) from numerous experiments that he is in agreement with this, and further that invertase properly employed gives in the case of beet molasses the same results as the new method using hydrochloric acid and urea, and as the old process using sulphurous acid.

We have studied the application of hydrochloric acid and urea mixture, and of sulphurous acid, to the analysis of cane products, especially of cane molasses, and have found that the action of the two is not quite similar.

The reason of this is that in low cane products the sugars and non-sugars are in all probability not the same. On the contrary, there are present from 10 to 30 per cent. of reducing substances.

In analysing molasses there are different procedures by which the crystallizable sugar may be obtained by inversion. Either the Zamaron method with hypochlorite decolorizing agents may be used; or basic lead acetate may be employed for the defecation of the liquid, different reagents, such as sodium sulphite, sulphurous acid, sodium phosphate, &c., being added to precipitate the excess of lead.

But there is a point which appears to have passed unnoticed. On adding the hydrochloric acid for inversion, the rotatory power of the reducing sugar which is already present is modified, so that after inversion the observed polarization is not due solely to sucrose hydrolysed to invert sugar.

The levo-rotation of an invert sugar solution increases with the hydrochloric acid concentration. Consequently, on adding the hydrochloric acid for inversion the reducing sugar already present causes a change in the rotatory power, increasing the levo-rotation. This increase in the rotatory power augments the levo-rotation corresponding to the amount of hydrolysed sucrose. Thus the value for the sucrose becomes too high.

If, however, before inversion the liquid is polarized with the addition of 10 c.c. of the hydrochloric acid and urea mixture, and this direct polarization taken with the inversion polarization (for which only hydrochloric acid, and no urea is used) the actual amount of sucrose present is obtained, since the change of rotation is due only in this case to hydrolysed sucrose.

We have studied the application of sulphurous acid to cane molasses, but in this case this acid does not give the same results as in the analysis of beet products, since it has not the same action upon the levo-rotation of reducing sugar as hydrochloric acid. Hence the hydrochloric acid and urea is indispensable for effecting the exact estimation of sucrose in cane molasses.

It is this change of rotation, caused by the direct influence of hydrochloric acid on solutions containing only reducing sugar, that has led to strange polarimetric observations in the analysis of certain products. Thus De Vilmorin and Levallois when analysing fodder beet juices containing 2·44 per cent. of reducing sugar, and no sucrose, were astonished to observe a direct reading of + 0·5°, and after inversion to have the polarization of 0°, although there was no change in the proportion of the reducing sugar.

But the polarization having changed, this is what had happened: A slight excess of basic lead acetate had probably been added to defecate the liquid, and the reducing sugar then had a diminished levo-rotation corresponding to + 0·5°. This + 0·5° represented the excess of the rotation of the dextro-rotatory reducing sugar over the rotation of the levo-rotatory reducing sugar. On adding the hydrochloric acid for inversion, the dextro-rotation had immediately disappeared, and the rotation had become zero, without there being any sucrose hydrolysed.

This change of polarization takes place immediately, and in the cold. The experiment can be repeated by making a 2·5 per cent. solution of reducing sugar, in the proportions of 35 to 36 per cent. of levulose, and 64 to 65 per cent. of dextrose. The polarization of this liquid will be slightly dextro-rotatory; but on taking 100 c.c. of it, and adding 10 c.c. of hydrochloric acid, the direct polarization will be diminished to zero, or perhaps be slightly to the left. This phenomenon is due exclusively to the influence of the acidity on the reducing sugar, and especially on the levulose present.

It is evident that the product analysed by De Vilmorin and Levallois contained reducing sugar in different proportions to those existing in invert sugar, but corresponding to a mixture having a rotation almost zero or slightly to the right. It is possible that the beet juice initially contained only invert sugar, but that the defecation precipitated some reducing sugar, principally levulose, for it is now well known that, in presence of foreign substances giving a more or less voluminous precipitate with basic lead acetate, this reagent is capable of precipitating 10, 20, or 30 per cent. of the reducing sugar present, principally levulose.

Thus it is seen that in the analysis of all products containing reducing substances the direct polarization must be made with the use of hydrochloric acid and urea. We have carried out experiments in this direction which leave no doubt in the matter, and this is why we have thought it useful to our colleagues to publish this note.

SOME NOTES ON ANIMAL CHARCOAL.

By William Clacher, F.C.S.

At the present day the manufacture of animal charcoal is to all intents and purposes as it was a generation ago, although it is true that modifications have been made in many important details. Different makers, for example, have improved their char by kilning the bones at what they consider the best heat, and by otherwise treating the bones so as to get a char with a good fracture and high decolorizing value.

The decolorizing value of the carbon in a new char is not a very good criterion of its real value. An overburned new char carbon is of high decolorizing power, while an underburned new char carbon is often of particularly low decolorizing power. In the latter case a few re-burnings makes the decolorizing value equal to that of the former, and the other properties of the char with the initial low decolorizing power possibly quite counterbalance the disadvantages of the extra kilning required at the refineries. A noteworthy fact in regard to the decolorizing value of carbon is that spent char carbon—I do not say in all cases this is so—is of much higher decolorizing power than new and new stock char carbon.

The working of char in a refinery is the most difficult part of the whole process; apportioning the liquors going on and separating them after coming off the char, washing away the liquors from the char when its decolorizing value is for the time small, washing the char to remove soluble organic matter, and kilning, are all operations that require attention and accurate scientific control.

An improvement which will in any way simplify the working of the cistern house will be a boon to refiners.

My attention has been drawn to a possible solution of some of the difficulties of char cistern work, *i.e.*, to use a charcoal block in place of granular char. That a block of animal charcoal of good porosity, high tenacity, and normal decolorizing value is producible, there is every reason to believe. The manufacture of blocks of a size sufficiently large to displace the present method of using char is a problem more mechanical than chemical. Carbon blocks, 4 ft. long and 1 ft. square, are produced for manufacturing carbide of calcium, and this is by no means the limit of size producible.

The advantages of a system of using blocks in place of granular powder are many; and of these only those which are important are enumerated:—

1. A better separation of liquors can be obtained when one liquor succeeds another on the same char.
2. Less water is required for washing.
3. Mechanical arrangements can be made to prevent running liquor to drain.
4. Water considerably above 212° F. can be used for washing the plates.
5. There is less danger of liquors souring on the char.
6. A more compact arrangement of plant and cleaner surroundings is effected.

The arrangement, adaptable to a vertical cistern of moderate size, is shown in the accompanying sketch (*Fig. 1*), in which A are the inlets for liquor, steam, compressed air, and water; B are the charcoal blocks; and C the outlet from cistern for liquors and washings.

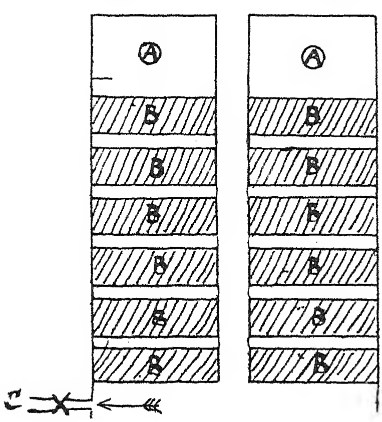


FIG. 1.

Regarding kilning, as at present carried out with Scotch kilns, heating by fires is still most in vogue. Where producer gas has been applied, success has not always followed, the reason is that when the

producer gas is burnt in such a way that the flame comes in contact with iron, iron-carbon compounds are formed which scale off, decreasing considerably the life of the kiln pipes, consequently making the cost of upkeep very high. There is, however, every reason to believe that when properly applied, producer gas will be much more economical than direct firing.

A producer rightly charged and poked at regular intervals gives a very constant gas. When the gas is unwashed, and the flues are cleaned weekly, a little watchfulness saves a deal of variation in the quality of the gas produced and makes for economy, in that the charges, immediately after cleaning, can be made equally small as those just before cleaning, otherwise the consumption during the first day after cleaning will be double that on the day before.

The correct way to apply producer gas to such a char kiln is to allow the flame to impinge on a firebrick baffle, and to pass the hot gases through the pipe chamber in the customary way. To get economy with such an arrangement, the air for combustion should be led through enclosed ducts in the firebrick baffles. In this way a much higher temperature is produced by the burning of the gas, or, in other words, less gas being needed to get the same amount of total heat.

Such an arrangement is shown in the following sketch (*Fig. 2*), in which A A are the hot air ports; B, the pipe chamber; C, the baffle wall of firebrick, containing enclosed channels to heat the air previous to entering the mixing chamber E; D, the air inlet to ducts; and F, the flame outlets.

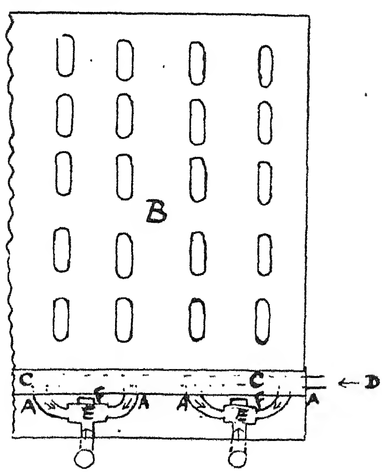


FIG. 2.

THE QUESTION OF DECOMPOSITION IN THE PAULY PRE-EVAPORATOR.*

By J. J. HAZEWINKEL.

Director of the West Java Sugar Experiment Station.

Frequently the apprehension is expressed that the Pauly apparatus may give rise to decomposition owing to the high temperature used.

It appeared to the author to be desirable to investigate this. In doing so, the Pauly used was capable of receiving steam at a maximum of 2 atmospheres, and the vapour from the juice could rise to 0·55 atmosphere; whilst the other data were: total height, 4·7 m. (15·4 ft.); total heating area, 150 sq. m. (1614 sq. ft.); total number of tubes, 652; space between the tube plates, 1·5 m. (4·9 ft.); height of the calandria, 2·6 m. (8·5 ft.); and diameter of the calandria, 2 m. (6·5 ft.). The tube plates were of bronze, and the tubes of brass.

In all the tests made, samples of the juice entering and leaving the Pauly apparatus were taken each quarter or half-hour, and determinations of the Brix (refractometrically), the polarization, and Clerget values were made, after reducing the samples taken on leaving the apparatus to the same (refractometric) density as those entering it. The steam pressure was 1·2 to 1·4 of an atmosphere. The following results were obtained:—

No.	Brix refract.	Pol.		Difference in Pol.	Clerget.		Difference in Clerget	No.	Brix refract.	Pol.		Difference in Pol.
		Entering.	Leaving.		Entering.	Leaving.				Entering.	Leaving.	
1	18·93	16·11	16·19	+ 0·08	16·25	16·43	+ 0·18	10	17 03	14·52	14·56	+ 0·04
2	17·05	14·27	14·30	+ 0·03	14·58	14·51	— 0·07	11	16·95	13·80	13·85	+ 0·05
3	17·28	15·05	15·06	+ 0·01	15·18	15·20	+ 0·02	12	18·38	15·42	15·56	+ 0·14
4	18·35	15·49	15·62	+ 0·13	15·67	15·86	+ 0·19	13	17·63	15·16	15·27	+ 0·11
5	19·20	16·75	16·61	— 0·14	16·90	16·75	— 0·15	14	16·04	13·29	13·30	+ 0·01
6	19·72	17·72	17·54	— 0·18	17·93	17·89	— 0·04	15	14·75	12·91	12·85	— 0·06
7	17·68	15·31	15·27	— 0·04	15·49	15·51	+ 0·02	16	13·10	11·23	11·35	+ 0·12
8	20·68	18·11	18·11	± 0·00	18·30	18·38	+ 0·08	17	16·53	14·18	13·99	— 0·19
9	20·72	17·60	17·48	— 0·12	17·93	17·79	— 0·14	—	—	—	—	—
—	18·85	16·27	16·24	— 0·03	16·47	16·48	+ 0·01	—	16·30	13·81	13·84	+ 0·03

It is seen that in all cases there is little difference in the polarization and Clerget values.

On several occasions the author has pointed out that in such determinations too much weight must not be attached to a similarity of purities, since both sucrose and levulose may be destroyed without

* Abridged from the *Archief.*

affecting the balance. Reducing sugar determinations, however, are absolutely necessary.

So as to shorten the time taken in reducing sugar determinations, advantage may be taken of the property that dextrose and levulose reduce in the cold. If dextrose and levulose solutions, having the same reducing power, are allowed to stand for 24 hours, with the same excess of Fehling's solution, in each case at the end of 24 hours equal amounts of Fehling's solution remain, so that equal amounts of both solutions have been reduced.

This may serve to indicate the difference of reducing power. In all our determinations the method was applied in the following way: 20 c.c. of the solutions used for polarization were treated with 70 c.c. of Fehling's solution, and made up to 100 c.c. After standing for 24 hours, 25 c.c. of the clear blue liquid was filtered off, boiled with an excess of invert sugar, and the cuprous oxide estimated by the permanganate method.

It should be pointed out that reduction in the cold does not indicate the glucose content, and is only applicable for comparison in identical solutions, when treated under the same conditions. Still, the method is very convenient.

Summarizing the figures for all 16 tests, and including the figures for the reducing sugars, we have:—

	Increase in Polarization.	Increase in Clerget.	Increase in Reducing Power.
First 9	0·03	0·01	1·3
Second 7..	0·03	—	0·7
All 16..	0·00	—	1·1

It is thus seen that there is a difference, but that it is extremely small.

In the last 8 samples the glucose factor was ascertained with the following results:—

	10	11	12	13	14	15	16	17
Entering the Pauly ..	8·88	16·23	10·38	8·90	9·48	8·21	11·40	10·15
Leaving the Pauly ..	8·65	16·03	10·41	9·03	9·62	8·06	11·28	10·29
Difference	— 0·23	— 0·20	+ 0·03	+ 0·13	+ 0·14	— 0·15	— 0·12	+ 0·14

On the average the glucose factor only falls 0·03. It can therefore be accepted with certainty that in the Pauly, with a pressure of 1·2 to 1·4 of an atmosphere, there is no appreciable decomposition, either in the form of inversion, or from destruction of glucose. It yet remains to experiment with pressures at the maximum of 2 atmospheres, and these figures will be given in a later publication.

A RATIONAL METHOD OF WASHING FILTER PRESS SCUM WITH A MINIMUM AMOUNT OF WATER.*

By N. Marx,

Redjoagoeng, Java.

On examining the control figures for the 1908 crop (*Archief Suikerind. Neder.-Ind.*, 1909, No. 9) it is seen that the sugar content of filter press scum from different factories differs considerably.

According to these data, of the carbonatation factories 5 had a sugar content in their press scum of 4·11 to 4·8; 1 had 3·98; another 2·75; 2 had 1·22; and 3 had less than 1 per cent. For the defecation factories we find: 2 with 11·20; 6 with an average of 10·45; 14 with 9·1 to 9·95; 30 with 8·1 to 8·9; 24 with 7·0 to 7·9; 12 with 6·0 to 6·9; 3 with 5·0 to 5·4; and 4 each with 4·6, 3·9, 1·79, 1·49 per cent. respectively of sugar.

From these figures it is apparent that only a few factories are conspicuous by a specially low sugar content in their filter scum, and the conclusion can well be drawn that most of the factories only use the ordinary method of steam and water washing, endeavouring in this way to get as complete a "sweetening off" as possible.

With these figures before us I wish to draw attention to the washing method of Fogelberg and Gredinger, which has given excellent results in Germany and Austria, and by means of which scum containing only 0·4 to 1·0 per cent. of sugar may be obtained. By applying this method, carbonatation factories with their large quantities of filter scum would profit most.

In filter press washing it is possible to displace the juice remaining in the cakes by a thin sugar solution as well as by water, provided that the concentration of the sugar solution be gradually diminished as the scum is lixiviated, pure water being finally employed.

Fogelberg accomplishes this by dividing the wash-water of the presses into two parts: (1) the concentrated "first-runnings" (*Vorlauf*); and (2) the following thinner "after-runnings" (*Nachlauf*). The first-runnings are mixed with the juice, but the after-runnings are pumped into tanks to serve as wash-water in the first "sweetening off" of the next press.

While Fogelberg works with equal parts of first and after-runnings, Gredinger divides this sweet-water into several parts. According to the first method of working, a tank divided into two by a partition suffices; but in the second, four or more tanks are necessary. Where by the Fogelberg procedure the cake cannot be washed with two runnings and a certain amount of water, by the Gredinger method in which four runnings are used, there is a greater certainty of a

* Specially translated from the Java *Archief* for this *Journal*.

complete exhaustion. Definite data, however, cannot be given here, and each factory must establish for itself the more suitable method, since the capacity of the evaporating plant must always be taken into consideration.

When working according to the Fogelberg method it is necessary to have an iron tank divided into two parts, either of which may act as an independent apparatus. Horizontal bottoms form small sub-divisions, which are connected with each other by valves, opened and closed by the liquid itself. The runnings from the press enter this tank from the top, and each division on filling is automatically closed, so that the mixing of the liquid with its gradually decreasing sugar content is not possible. A second tank serves as water reservoir, and both tanks are connected with the pump used for scum washing.

The size of the tanks is regulated by the size of the presses, and by the extent of washing required. Fogelberg gives as example two apparatus both of 2 cubic metres (70 cubic ft.) capacity: one apparatus for three small Kroog's presses having 36 plates, 750 mm. (30 in.) square; and the other apparatus for three larger presses of 36 plates, 800 mm. (31 in.) square. The thickness of the cake is 26 mm. (approximately 1 inch).

The method of working is as follows: At the commencement when the first press is to be washed, and there is no sweet-water at hand, fresh water is used. One division of the tank is filled with 1000 litres (220 gall.) of water, and the scum-pump set in action. The first 500 litres (110 gall.) are allowed to flow into the juice, but the other half is returned to the empty division of the tank. On "sweetening off" the next press, this returned 500 litres (110 gall.) is first used, and then another 500 litres (110 gall.) of water from the water reservoir. The first half is mixed with the juice, while the second half is returned to the tank to be used for the next press.

In this way concentrated first-runnings and dilute after-runnings are obtained. Of course, if this amount of water is insufficient to effect a low sugar content, it must be increased. According to Fogelberg, 1200 litres (264 gall.) are necessary for the large press, and 950 litres (210 gall.) for the small one, to obtain a sugar content of 0·5 to 1·0 per cent. With a filter press capacity of 925 (18 cwt.) and 725 kilos. (14 cwt.) of scum per press it is found on calculation, that the water required per press is 129·7 and 131·0 per cent. respectively of the filter scum, of which, however, only half, *i.e.*, 64·8 and 65·5 per cent. respectively, is mixed with the juice. Washing is effected in both presses by the water-channels, and lasts 12 to 15 minutes per press.

The Gredinger "sweetening off" method depends on the same principle as that of Fogelberg, differing only in a different division and application of the sweet-water. Gredinger divides the sweet-water into four parts, each of which is collected separately. The first

is mixed with the juice, while the second, third, and fourth serve for "sweetening off" the next press, the last washing being made with pure water. For wash-water, warm condenser water from the effect under a pressure of 3 atmospheres is used.

It seems to me that this method of washing can be applied in Java with success, and I hope by this explanation to have indicated a way of obtaining a more complete exhaustion of the press scum.

During this campaign, comparative experiments on filter press scum washing were made at Redjoagoeng, using steam and warm condenser water from the effect, under pressure of 3½ atmospheres. But the method described above could not be fully followed out, since a pump was wanting, and all the necessary piping was not at hand.

Washing was accomplished in each press by three full juice-channels, each 118 litres (25 gall.) capacity; the first 118 litres (25 gall.) of sweet-water were mixed with the clear juice from the presses; while the second and third runnings were collected in a tank, and used for the imbibition of the first mill bagasse. Here follow the average analytical figures of the investigation:—

Thin-juice. A.				
Brix.	Sugar.	Purity.		
14·70	13·14	89·39	6·2 per cent. sugar in the scum.	Washed with steam.
15·60	14·38	92·11	6·4 " " "	
15·15	13·76	90·82	6·3 per cent. sugar in the scum.	

Thin-juice. B.			I.—118 litres (25 gall.) of sweet-water.			II.—118 litres (25 gall.) of sweet-water.			III.—118 litres (25 gall.) of sweet-water.			Sugar content in scum.
Brix.	Sugar.	Purity.	Brix.	Sugar.	Purity.	Brix.	Sugar.	Purity.	Brix.	Sugar.	Purity.	Per cent.
14·90	13·38	89·79	7·0	6·26	89·43	2·9	2·09	72·06	1·9	1·10	68·75	1·9
15·10	13·89	91·98	8·0	7·18	89·75	3·3	2·49	75·45	1·8	1·29	71·66	1·9
14·90	13·45	89·96	8·2	7·23	88·17	3·8	3·03	79·73	2·0	1·45	72·50	2·0
14·96	13·57	90·70	7·73	6·89	89·13	3·33	2·53	75·97	1·9	1·28	67·36	1·93

Thus there is an average decrease in the sugar content of the scum of 4·73 per cent. by washing with warm water in the manner described.

PUBLICATIONS.

English-Spanish and Spanish-English Technical and Commercial Dictionary. By William Jackson. 164 pp. 2s. 6d. net. London, E. and F. N. Spon Ltd. New York, Spon and Chamberlain, Liberty Street.

This is one of those desk helps which are frequently wanted and all too seldom forthcoming. When one attempts to translate technical matter, the ordinary dictionary is apt to be uncertain and unsatisfying. In this work the compiler has tried to make up a comprehensive list of the expressions used in the iron, steel, hardware, and machinery business with a view of furthering commercial relations of the Spanish speaking countries of America with the United Kingdom and United States. He has certainly produced a useful collection, but we could have wished that he had had before him a leading sugar machinery manufacturer's catalogue, or even the advertisement pages of this *Journal*, as he would then have been able to do this trade better justice in his pages. The latter take no cognisance of such words as *vacuum pan* (nor of *vacuum*), *crystallizer*, *triple effect*, *clarifier*, to mention only a few of the words that occur to us. But doubtless in a later edition these omissions will be repaired.

The Sugar Industry of Mauritius: A Study in Correlation. *Including a Scheme of Insurance of the Cane Crop against Damage caused by Cyclones.* By A. Walter, F.R.A.S., Chief Assistant, Royal Alfred Observatory, Mauritius. London, Arthur L. Humphreys, 187, Piccadilly. 1910. Price, 12s. 6d. net.

This work, which is described as a "Study in Correlation," owes its origin to efforts on the part of the authorities of Mauritius to determine definite relations between the cane crops of that island and the meteorological conditions, an important subject in connection with hurricane insurance in relation to growing crops. The work, therefore, teems with statistical technicalities, which only appeal to the *cognoscenti*. There is, however, coupled with this primary matter, much that is of interest to the sugar producing world. In fact, the history of the sugar industry of Mauritius, set forth in a nutshell form in the pages of this well-got-up volume, may be taken as that of those other countries which form the old guard of the world's cane sugar producers. As regards Mauritius, the author states that capital expenditure on factory improvements has been, and will

still continue to be for some years, excessive. As a set-off, however, the cost of production has already decreased on many estates from Rs. 9·80 per 100 lbs. (£14 11s. per ton) to Rs. 5·64 (£8 8s. per ton), and, when the capital charges are deducted, to Rs. 4·90 per 100 lbs. (£7 6s. per ton); and the author further states that "the time is not far distant when the cost of production will fall to Rs. 4 (£6 per ton), and probably below it on the best equipped and best managed estates." As a proof of the vitality of the Mauritius sugar industry, the total output has risen from 106,000 tons in 1886-7 to 247,000 tons in 1909-10. The Appendix includes a chapter on the mathematical methods employed in the statistical part of the work.

ABSTRACTS, SCIENTIFIC AND TECHNICAL.*

BACTERIAL DETERIORATION OF SUGARS. *By W. L. Owen. La. Planter, 1911, 46, 153-155.*

In an interesting paper read before the Louisiana Sugar Planters' Association on March 9th, 1911, the author pointed out that it is well known that certain bacteria are associated with the deterioration of finished sugar during storage. Exhaustive investigations carried out at the La. Sugar Experiment Station have shown that the particular bacteria in question belong to the so-called "potato group," which is characterized by the very high resistance of its spores to heat, and that these bacteria occur in all sugars irrespective of their origin or conditions of manufacture. Bacteriological experiments conducted in the experimental factory during 1908 had been made, every product beginning with the juice and finishing with the sugar being carefully examined throughout the season. As a result, it was conclusively proved that the initial contamination of the mill juice with these deteriorative bacteria was not eliminated in any of the various stages of manufacture, but that the spores of the organisms persisted throughout the entire process. Sulphuring, however, was found to considerably reduce the number, while defecation appeared to destroy all but the spore forms. As to the nature of the action of these organisms on the sugar, it has not been determined so far whether the sucrose (cane sugar) is directly inverted, with the formation of dextrose and levulose (invert sugar), or whether acids were developed and inversion indirectly brought about in this way. At one stage of the investigation results were obtained indicating that certain bodies capable of introducing an error into the analytical work had been formed. Although it was known that the sucrose was diminishing in amount owing to the action of the

* These Abstracts are copyright, and must not be reproduced without permission.—(ED. *I.S.J.*)

deteriorative organisms, yet the Clerget method actually showed increasingly higher values. A closer examination demonstrated that these strange results were due to the presence of an optically-active gum resulting from the action of the bacteria, which vitiated the polarimetric readings, and by precipitation with alcohol bodies were obtained resembling to some extent the gum levan. Regarding remedial measures, the great importance of cleanly conditions in the sugar house is emphasized. Ammonium fluoride in a 1 per cent. solution is recommended as preferable to ordinary milk-of-lime as an antiseptic wash for tanks, pans, pipes, &c. Mercuric bichloride (corrosive sublimate), one part in 1000 of water, gives very beneficial results in keeping the floor, walls, and general woodwork of the factory free from micro-organisms; while a 2 per cent. solution of phenol (carbolic acid) will likewise be found to give good results. Formaldehyde (formaline) is always to be preferred for preserving juice which has to be kept on hand, and a suitable strength in which to use it is one part in 5000. A second remedial method is drying, and this is a practicable and infallible measure. It has been claimed that sugars containing less than 1 per cent. of moisture cannot support bacterial life, but although the author's results so far do not entirely confirm this statement, they show that to a large extent it is true. In the investigation it was discovered that deteriorative bacteria developed more readily in an alkaline than in an acid medium. This applies more particularly to refineries which work alkaline; for although there may be no danger from inversion when working alkaline, it is suggested that it may be found better when making sugar for long storage to use an acid medium, and that the methods of certain refineries may be modified accordingly.

THE WISCONSIN EXPERIMENTS ON SHREDDED CANE. *By S. G. Ruegg. La. Planter, 1911, 46, 69.* Compare also this *Jl.*, 1910, 307, 313; and 1911, 634, 160.

In giving some particulars concerning the history of cane desiccation it is stated that George W. McMullen, of the Armour Institute, Chicago, was the first to endeavour to dry beets, so as to enable factories to run all the year round, instead of only during a short campaign,* and a saving of $20 a ton in the production of beet sugar

* This is, of course, quite incorrect, for about 40 years ago desiccation experiments with beets were made in factories in Europe, but were unsuccessful. Moreover, cane desiccation is by no means a new idea, since many years ago efforts were made to dry cane in the West Indies, and ship the product to England, for extraction there. Thus British Patent 12,033 of 1848 describes a method of "extracting the sugar from the sugar cane by first drying and pulverizing, and afterwards extracting the sugar therefrom by passing water through it in vessels." This project was likewise a failure.—(Ed. *I.S.J.*)

over the ordinary method was claimed. Later, the process was applied to cane, and this was found to be a more promising field, since (*a*) two tons of cane could be raised for the same cost as one ton of beets, with about the same sugar content, and (*b*) the by-product of cane was more valuable than that of beet. McMullen tested various shredders, and ultimately found one capable of reducing the woody fibre and pith to a fine mass without loss of juice. At first he tried drying pith and fibre separately, then together, but he found that in either case the water could be readily expelled and the sugar left behind in the crystallizable form. It was also found that no inversion of the sucrose (cane sugar) occurred during drying, and that on extraction the sugars went easily into solution, owing to the fact that during shredding and drying all the cell walls had been ruptured. Pith was found to contain more sugar than fibre, and the former constituent was shown to yield a cellulose of special value for certain purposes, such as the manufacture of smokeless powder, celluloid, &c., while the fibre was discovered to make excellent magazine paper, and by a special treatment could produce a writing material of unusual strength. Commenting upon the Wisconsin experiment, it is pointed out that, striking though it may seem, the new method means the extraction of the entire sugar content of the cane (*cf.* this *Jl.*, 1911, 161), whereas by the method now in vogue only about 80 per cent. of the sugar content is obtained. Owing to the complete extraction of the sugar, the improvement in the character of the juices, and the use of the by-products, it is claimed that the returns would be $2, where previously only $1 had accrued. It is further stated that the drying need not cost more than $1 per ton, so that $2 a ton more return on every ton of cane, plus the extra $3 to $4 on every ton for the different kinds of cellulose, would be assured.

Laboratory Experiments on the Double Liming of Cane Juices. *By J. J. Hazewinkel.* *Archief Suikerind. Nederl.-Ind.* (*Java*), 1911, *aflev. 6, 166-174.*

By "double liming" is understood tempering in two separate operations. When adding the first quantity of lime, sufficient is used to leave a slight litmus acidity, after which the juice is heated slowly until "top separation" is effected. Generally this happens between 70 and 85°C., the scum forming a compact thick layer, leaving the liquor below considerably clearer and lighter in colour than the original juice. In this way, it is stated, substances decreasing the viscosity of the juice are separated, which in the ordinary alkaline mode of working would have remained in solution. After this the scum is separated preferably by drawing off from below,

the clear juice obtained being then treated with the remainder of the lime, and heated up in the ordinary way, being finally subsided. Working with both normal and abnormal juices on two different Javan estates, the author has carried out a number of laboratory clarification experiments, as the result of which he comes to the following conclusions: In every case the thick-juices obtained by the double liming process were considerably lighter in colour and clearer than the thick-juices resulting from ordinary direct tempering. With abnormal juices, however, the proposed new method cannot be recommended as a corrective, for then in order to effect subsiding a large excess of lime, viz., 8 to 10 litres of 15° Bé. milk per 1000 litres of raw juice, is necessary. In consideration of the favourable results with normal juices it is now proposed to proceed to tests on the large scale, and these will be reported upon later. It is suggested that the most suitable plant for the technical application of the double liming process would be a number of round-bottomed tanks, each provided with an out-let at the bottom. When carrying out the first liming, the juice would be run off, and the scum passed into filter-presses, the clear liquid thus obtained being united with that run out of the tanks. After completing the defecation, the juice would be heated, and then subsided in the ordinary way.

On the Iron Content of White Sugars and the Grey Colour of First Sugars of the Campaign. *By D. R. Holm.*

Archief Suikerind. Nederl.-Ind. (Java), 1911, aflev. 1, 14-20.

Prinsen Geerligs, in certain of his remarkable researches, has shown that when iron occurs in raw cane sugar it is not all dissolved in the adhering syrup, but is incorporated in the form of a chemical compound in the sugar itself. When this research of Geerligs was carried out in Java the sugars were obtained by the neutral method of working then in vogue. In now extending this result to sugars obtained from massecuites having an appreciably acid reaction, the author has found that the extent of the contamination of a sugar with iron is strongly affected by (*a*) the reaction of the massecuite, the iron content decreasing with the acidity, and (*b*) the presence of reducing substances in the massecuite. On examining Javan sugars of the 1909 and 1910 campaigns, it was observed that the amount of iron present was about one-half of that found by Geerligs with sugars obtained by the neutral process, and it is therefore concluded that by sulphuring the thick-juice the crystallizing-out of the iron with the sugar is to a large degree prevented. Next, the question is asked: To which property of the sulphurous acid—to its effect as an acid

or as a reducing agent—is this favourable result to be ascribed? Answering this, the author considers that the reducing action of the acid is the minor rôle, but that the principal effect of the sulphurous acid in respect of separating the iron is that it decomposes the complex compounds in which the iron is combined with the sugar, freeing the iron to make an ordinary salt, with the metal as ion. That this is so, and that any acid, whether or not it possesses reducing properties, is able to prevent the crystallizing-out of the iron with the sugar, was demonstrated by the author by experiments with pure sugar solutions, to which had been added definite amounts of iron citrate and citric acid. In the second part of this article the cause of the bad colour of the first white sugars for the Indian market of a previous campaign is discussed. It had been noticed by the author that the separation of the iron by sulphuring the thick-juice is not quantitative, a portion of the iron in one or other of the complex combinations with sugar always remaining behind, but that in proportion to the extent of sulphitation there is more or less of these complex combinations decomposed. At first, therefore, it was thought that the inferior colour might be due to carrying the sulphuring less far than usual, although further examination showed that this could not be so. Finally the conclusion was arrived at that the bad colour under investigation was not to be ascribed to iron at all, but to mechanical contaminations, such as might come from the walls of the juice tanks, of the pans, of the worms, or of the massecuite pipe.

Determination of "Gum" in Cane Molasses. *By J. J. Hazewinkel. Archief Suikerind. Nederl.-Ind. (Java), 1910, 18, 746-753.*

For the determination of "gum" in syrups and molasses, Tervooren in his "Methoden van onderzoek der bij de Java rietsuiker-industrie voorkomende producten," page 197, gives the following directions: 10 grms. of the sample are dissolved in about 10 c.c of warm water, the solution rendered acid with hydrochloric acid, then precipitated with alcohol. The precipitate, which should be loose and flocculent, and should not adhere to the sides of the beaker, is filtered through a dry, tared, ash-free paper, washed with alcohol, and placed in an oven at 102 to 105°C. until it is constant in weight. The filter-paper and precipitate are then burned in a platinum dish, after which, by subtracting the weight of the ash obtained from the weight of the precipitate, the amount of "gum" in 10 grms. of the sample is found. When working according to this method, the present author has repeatedly noticed that duplicate determinations do not give sufficiently con-

cordant results. On investigation, he found that the "gum" content of a molasses may vary from 0·78 to 2·44 in the same sample by using different proportions of the sample, of alcohol, and of acid; and it was further observed that appreciably lower results are obtained if the precipitate be allowed to stand for 24 hours in contact with the alcohol, instead of filtering the liquid without delay. It is pointed out that, with too small an amount of acid, organic salts may be thrown down with the alcohol precipitate, and that, on the contrary, if too much acid be used the gummy bodies may possibly undergo some decomposition. The concentration of the alcohol appears to the author to be of the greatest importance. Too small an amount may not separate all the gum from the molasses, whereas too great a concentration would have the effect of contaminating the precipitate with organic salts, and of thus giving too high results. Investigations on the correct amount of each reagent to be used, so as to give the most trustworthy values, are now proceeding.

Estimation of Reducing Sugar in Cane Sugars destined for the Refinery or for Consumption. *By C. Muller. Bull. Assoc. Chim. Sucr. et Dist., 1911, 28, 640-641.*

It has been noticed by the author that frequently the quantity of reducing sugar in samples of sugars is so small that even when only 0·5 c.c. of copper test is used it is difficult in the volumetric process to recognise the end-point of the titration. If double normal sugar-weight solutions are prepared, and more than 20 c.c. of the sugar-solution are used, the process loses in accuracy; so that, unless there is time to use the Pellet gravimetric process, results only more or less approximate are obtained. In order to obviate this difficulty, and to render the titration more accurate under these circumstances, the author recommends a modification of the volumetric process, in which a known amount of invert sugar is added to the assay liquid, and account taken of this when calculating the result. First, the invert sugar solution is prepared by hydrolyzing 4·75 grms. of purest refined in the ordinary way and making up to a litre. For the actual determination, twice the normal sugar-weight of the sample of sugar being examined is washed into a 100 c.c. flask, dissolved, defecated with 2 c.c. of neutral lead acetate, and cooled. Now 20 c.c. of the invert sugar solution (corresponding to 0·11 grm. of reducing sugar) are added, the liquid mixed, neutralized, made up to 100 c.c., and filtered. In this filtrate, the reducing sugar is ascertained in the usual manner, using 5 c.c. of Fehling's solution for cane sugars polarizing 98 to 99°. If P be the normal sugar-weight (French,

32·58, and German, 26·048 grms.); n, the number of c.c. of Fehling's solution used; and N, the number of c.c. read on the burette, then X, the percentage of reducing sugar in the sugar examined, is found by the following formula: $X = \dfrac{\dfrac{n \times 0{\cdot}005 \times 100}{N} - 0{\cdot}100 \times 100}{2\,PN}$.

It is stated that the results obtained in this way agree well with those obtained by weighing as cupric oxide, or by titration with stannous chloride or with cyanide solution. When there is present more than 0·5 per cent. of reducing sugar, there is no need to render the reaction more sensitive by adding invert sugar in the manner described, since the determination can then be carried out directly on the double normal sugar-weight solution with all necessary accuracy.

Preparation of a Stable and Sensitive Solution of Litmus.

By A. Püschel. Österr. Chem. Zeit., 13, 185-186.

Pellet has described a method of preparing sensitive neutral litmus paper, which is of much use in accurate work in the sugar house or laboratory. Now the present author gives the following procedure for preparing a sensitive solution of this indicator which should likewise prove of value: 100 grms. of commercial litmus are boiled with 600 c.c. of distilled water, and set aside in a cool place. After subsidation, the clear liquid is decanted off, evaporated to 200 c.c., filtered, and the volume made up to 300 c.c. with distilled water. A solution of 16·2 grms. of pure concentrated sulphuric acid in 100 c.c. of water is then added, and the mixture heated in the water-bath for four hours, being shaken from time to time. The precipitate which then forms (presumably the sulphonate of the litmus-colouring principal) is collected on a filter, and washed with cold water. Washing should be continued until the wash-water assumes a pecular fiery red coloration and a small portion gives on addition of dilute caustic soda solution a colour that is deep blue and not violet. When this stage is reached, 100 c.c. of lukewarm alcohol of 90 per cent. concentration, to which a few drops of ammonia have been added, are poured on the filter, by which treatment the pure colouring matter of the indicator is removed. This extract is next evaporated to dryness, and the residue, dissolved in 600 c.c. of distilled water and carefully neutralized to a pure violet tint, gives the stable and sensitive litmus solution recommended by the author.

Manures for the Sugar Cane and their Application. *By W. van Deventer.* Paper contributed to the 9th Congress of the *Algemeen Syndicaat van Suikerfabrikanten in Nederl.-Ind.*, held at Soerabaia, Java, in March, 1911.

Summarizing the experience gained from extensive field trials in different parts of Java with a variety of manures and different canes, the author draws up the following general conclusions: Sulphate of ammonia has proved so far the most suitable manure for the sugar cane, but the proper amount to be used depends in the first place upon the soil, and in the second upon the variety of cane, while the time of its application is likewise dependent upon several circumstances, principally the weather, the soil, and the cane variety. As to the method of its application, this is of secondary importance, provided the manure be not mixed with alkaline substances. Chili saltpetre, applied at the same time as sulphate of ammonia, is of less value, except during dry seasons, and on dry soils, when it is probably superior, It should not be combined with superphosphate or Thomas meal. Earth nut cake stands 8 per cent. lower in nitrogen value than sulphate of ammonia. Its high nitrogen price makes it an uneconomical manure, but whether its manurial value could be raised by combination with sulphate of ammonia has not hitherto been determined. Peru guano, on account of its high price and low nitrogen value, is unprofitable, so far as Javan conditions are concerned. Stable manure has a small nitrogen value, but is of use as an organic and phosphoric acid fertilizer, and should be applied early. Green manure is useful on account of its nitrogen, but is probably of more value as a source of organic matter. Double superphosphate is the most profitable phosphoric acid manure for Java. It should be applied early. Sulphate of potash has proved unsatisfactory on many light and heavy soils and in admixture with plenty of nitrogen. Boiler ash and defecation scum are of value as phosphoric acid manures. Molasses has in certain cases proved a valuable manure, although its action is not entirely understood (cf., Peck, this *Jl.*, 1911, 109).

THE WORLD'S SUGAR CONSUMPTION.

(In Tons of Raw Sugar.)

	1901-1902.	1902-1903.	1903-1904.	1904-1905.	1905-1906.
Germany..........	745,400	788,800	1,137,200	966,000	1,128,000
Austria-Hungary ..	390,400	381,900	504,000	445,000	524,000
United Kingdom ..	1,844,200	1,540,400	1,548,000	1,516,300	1,711,900
France............	480,000	412,400	776,700	602,600	646,100
Belgium	66,000	70,000	92,200	79,700	88,300
Holland	67,000	70,800	88,400	90,200	98,400
Russia	786,600	814,400	848,800	942,200	967,000
United States	2,374,800	2,647,600	2,642,700	2,712,200	2,943,900
British India......	2,312,800	2,164,800	2,176,000	2,500,500	2,067,000
Other Countries....	2,896,600	2,435,800	2,792,400	2,028,000	3,749,100
Total Consumption..	11,963,800	11,326,900	12,606,400	11,882,700	13,924,300
Total Production ..	12,948,900	11,683,800	12,059,900	11,642,200	13,959,000

	1906-1907.	1907-1908.	1908-1909.	1909-1910.
Germany	1,161,200	1,198,100	1,250,000	1,262,600
Austria-Hungary......	533,000	543,600	576,200	592,100
United Kingdom......	1,717,500	1,710,600	1,809,500	1,639,500
France	638,700	649,600	671,500	675,700
Belgium..............	94,800	100,500	105,500	109,400
Holland..............	104,100	104,700	110,400	112,300
Russia	974,600	1,057,500	1,107,000	1,286,000
United States	3,088,900	2,965,600	3,240,000	3,252,000
British India	2,761,000	2,543,100	2,442,000	2,642,400
Other Countries	3,165,800	3,145,800	3,578,500	3,540,200
Total Consumption....	14,239,600	14,019,100	14,890,800	15,112,200
Total Production......	14,464,000	13,890,000	14,543,000	14,836,000

The above table was compiled by Dr. Bartens, and first appeared in the *Zeitschrift des Vereins der Deutschen Zuckerindustrie.* We do not know where Dr. Bartens gets his figures from, but, all things considered, they balance fairly well. The discrepancy between the figures of "Total Production" and "Total Consumption" no doubt arises from the fact that they are drawn from various sources and hence never come out quite square. It is, however, doubtful whether the United Kingdom consumption figures are correctly rendered as "Tons of Raw Sugar," because we now reckon "Sugar Refined in Bond in the United Kingdom," which is the weight of refined turned out.

Estimate of Principal Cane Crops of the World

(From J. W. de Silva & Co.'s Report.)

		Crop made.	1910-11.	1909-10.	1908-09.	1907-08.
Chief Countries supplying Europe and America.	Java	May-Nov..	1,200,000	1,290,000	1,266,000	1,240,000
	Réunion	Aug.-Jan..	35,000	40,000	37,000	39,000
	United States..	Sept.-Jan..	300,000	330,000	370,000	352,000
	Peru	Oct.-Feb...	140,000	150,000	140,000	160,000
	Brazil	,, ,, ..	260,000	270,000	240,000	220,000
	Demerara	,, ,, ..	100,000	100,000	110,000	100,000
	Surinam and Venezuela.	,, ,, ..	15,000	16,000	15,000	15,000
	Hawaii	Dec.-April.	480,000	480,000	477,000	465,000
	Mexico	,, ,, ..	150,000	150,000	130,000	115,000
	Cuba	Dec.-June.	1,000,000	1,800,000	1,514,000	960,000
	Porto Rico....	Jan.-June..	300,000	308,000	240,000	190,000
	St. Domingo and Hayti.	,, ,, ..	70,000	69,000	62,000	50,000
	Trinidad and Tobago ..	,, ,, ..	50,000	55,000	55,000	48,000
	Barbados......	,, ,, ..	40,000	36,000	13,000	30,000
	Jamaica	,, ,, ..	10,000	7,000	5,000	12,000
	Antigua and St. Kitts..	,, ,, ..	20,000	25,000	22,000	20,000
	Other British West Indies	,, ,, ..	7,000	8,000	8,000	8,000
	Martinique	,, ,, ..	40,000	40,000	40,000	39,000
	Guadeloupe . ..	,, ,, ..	40,000	40,000	36,000	35,000
	St. Croix......	,, ,, ..	15,000	15,000	14,000	13,000
	Central America	,, ,, ..	15,000	15,000	14,000	15,000
	Total Tons............		4,897,000	5,244,000	4,808,000	4,126,000
Countries consuming own productions, or exporting chiefly to East.	Argentina	June-Oct...	140,000	130,000	164,000	109,000
	Australia and Fiji	June-Nov..	290,000	220,000	235,000	280,000
	British India..	Dec.-May..	2,100,000	2,125,000	1,900,000	2,050,000
	Egypt	Jan.-June..	50,000	50,000	48,000	60,000
	Formosa	Dec.-June..	200,000	160,000	125,000	80,000
	Mauritius	Aug.-Jan..	200,000	235,000	191,000	170,000
	Natal	,, ,, ..	70,000	63,000	35,000	34,000
	Philippines....	Nov.-Mar..	160,000	116,000	123,000	137,000
	Total of **Cane**........		8,107,000	8,343,000	7,629,000	7,046,000
	Beet—Europe		8,127,000	6,138,000	6,544,000	6,562,000
	,, United States.		445,000	450,000	384,000	440,000
	Cane and Beet		16,679,000	14,931,000	14,557,000	14,048,000

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E. Chartered Patent Agent, 6, Lord Street, Liverpool; 77, Market Street, Bradford; and 285, High Holborn, London.

ENGLISH.—Applications.

4519. C. Steffen. *Process for the extraction of the juice of saccharriferous plants.* (Convention date, 26th February, 1910, Belgium. Complete specification.) 22nd February, 1911.

4673. H. W. Aitken. *Hydraulic pressure-regulating apparatus for sugar cane mills.* (Complete specification.) 24th February, 1911.

5705. M. Naswanoff. *Manufacture of refined sugar.* 7th March, 1911.

Abridgments.

12385. J. Harvey, Glasgow. *Improvements in and relating to sugar cane mills and the like.* Date of application 21st May, 1910. This invention relates to sugar cane mills of the class in which a piston works in a hydraulic cylinder to take up the thrust of the top roller, parallel acting bars being operated to take up the thrust when desired.

12560. J. Harvey, Glasgow. *Improvements in and relating to sugar cane mills.* Date of application, 24th May, 1910. This invention relates to sugar cane mills having the top or crushing roller formed with a series of indented surfaces of wedge or double-tapered shape, with the wedge or double-tapered shaped segments arranged alternately at right angles to each other.

15603. C. G. Hurrey, Auburn, Victoria, Australia. *An improved cane harvester.* Date claimed for Patent being date of first foreign application (in Australia). 29th June, 1909. Date of application in United Kingdom, 29th June, 1910. This invention relates to a cane harvester of the kind provided with a rotary cutter wherein the cutter is fitted to a vertical spindle slidably mounted in bearings, a lever fulcrumed at or about its centre being pivotally connected at one end with said spindle and having a pulley on its opposite end, a flexible

member secured fixedly at one end being passed around said pulley to a winding drum, said drum being fitted to a shaft having an operating wheel or lever, and pawl and ratchet mechanism.

NOTE.—Copies of all published specifications with their drawings in these lists can be obtained from W. P. Thompson & Co., 6, Lord Street, Liverpool, at One Shilling each copy for English or American Patents, and Two Shillings for German. In ordering please give number and date.

At the request of the Board of Agriculture, experiments are to be conducted this season at the South-Eastern Agricultural College, Wye, in sugar beet growing. Trials in manuring and cultivation will be made, and special tools used on the Continent for lifting the crops will be tested.

Mr. R. N. Dowling, of the South-Eastern Agricultural College, Wye, Kent, has recently been appointed by the National Sugar Beet Council, to investigate in company with a German agriculturist the general conditions of sugar beet growing on the Continent in order to demonstrate to farmers in this country suitable methods for adapting the growing of the crop to English farming conditions. Mr. Dowling was for some time a lecturer at the above college, and has had a thorough scientific and practical experience, having himself farmed large areas of land.

UNITED KINGDOM.

IMPORTS AND EXPORTS OF SUGAR
To End of March, 1910 and 1911.

IMPORTS.

Unrefined Sugars.	1910. Tons.*	1911. Tons.*	1910. £	1911. £
Russia	....	....	....	....
Germany	68,522	139,687	912,422	1,353,409
Netherlands	3,994	3,164	47,385	28,539
Belgium	2,756	3,248	33,757	31,290
France	340	16	4,934	138
Austria-Hungary	34,387	29,786	458,947	295,408
Java	101	6	1,104	66
Cuba	9,418	....	137,972	....
Dutch Guiana	2,491	1,424	34,712	19,212
Hayti and San Domingo	17,803	8,242	244,149	86,400
Mexico	136	1,674	1,711	19,258
Peru	15,694	13,293	205,791	122,170
Brazil	16,345	924	196,465	6,809
Mauritius	7,632	11,854	98,365	100,711
British India	....	....	....	....
Straits Settlements	408	....	4,737	....
Br. West Indian Islands, Br. Guiana & Br. Honduras	23,827	9,941	335,154	125,481
Other Countries	5,194	3,607	66,358	32,892
Total Raw Sugars	209,079	226,867	2,783,965	2,221,788
Refined Sugars.				
Russia	94	11,418	1,452	135,129
Germany	95,755	101,463	1,453,034	1,287,119
Holland	25,343	31,903	397,242	428,079
Belgium	7,611	9,364	123,722	125,143
France	25,097	1,638	399,070	23,877
Austria-Hungary	46,402	49,854	720,783	641,945
Other Countries	3,894	51	61,368	630
Total Refined Sugars	204,197	205,691	3,156,671	2,641,922
Molasses	40,895	29,806	194,473	122,429
Total Imports	454,171	462,364	6,135,109	4,986,139

EXPORTS.

British Refined Sugars.	Tons.	Tons.	£	£
Denmark	1,004	1,098	13,571	12,338
Netherlands	877	809	13,186	10,538
Portugal, Azores, & Madeira	386	406	5,177	4,507
Italy	92	465	1,219	5,320
Canada	1,061	1,783	16,220	25,630
Other Countries	1,828	3,758	32,822	56,264
	5,247	8,319	82,195	114,597
Foreign & Colonial Sugars				
Refined and Candy	141	280	2,614	4,427
Unrefined	941	3,000	13,056	33,594
Various Mixed in Bond	10	....	150	....
Molasses	167	52	802	301
Total Exports	6,506	11,651	98,817	152,919

* Calculated to the nearest ton.

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1911. Tons.		1910. Tons.
Total Receipts January 1st to Mar. 30th	573,745	..	691,331
Receipts of Refined ,, ,, ...	222	..	13
Deliveries ,, ,, ...	556,880	..	673,486
Importers' Stocks, March 29th	16,865	..	21,195
Total Stocks, April 5th	174,000	..	330,070
Stocks in Cuba, ,, ...	320,000	..	356,000
	1910.		1909.
Total Consumption for twelve months ..	3,350,355	..	3,257,660

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR FOR 1909, 1910 AND 1911.

(Tons of 2,240 lbs.)	1909. Tons.		1910. Tons.		1911. Tons.
Exports	344,603	..	420,759	..	281,962
Stocks	238,470	..	308,277	..	265,619
	583,073	..	729,036	..	547,581
Local Consumption (2 months)..	10,775	..	11,730	..	11,870
	593,848	..	740,766	..	559,451
Stock on 1st January (old crop)..	....	..	....	..	....
Receipts at Ports up to 28th Feb.	593,848		740,766		559,451

Havana, 28th February, 1911. J. GUMA.—F. MEJER.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION OF SUGAR FOR THREE MONTHS ENDING MARCH 31ST.

	Imports. 1909. Tons.		Imports. 1910. Tons.		Imports. 1911. Tons.	Exports (Foreign). 1909. Tons.		Exports (Foreign). 1910. Tons.		Exports (Foreign). 1911. Tons.
Refined	216,772	..	204,197	..	205,691	239	..	141	..	280
Raw	166,075	..	209,079	..	226,867	600	..	951	..	2,999
Molasses	40,402	..	40,895	..	29,806	42	..	117	..	52
	423,249		454,171		462,364	881		1,209		3,331

	Home Consumption. 1909. Tons.		1910. Tons.		1911. Tons.
Refined	216,795	..	199,537	..	198,477
Refined (in Bond) in the United Kingdom........	150,979	..	143,955	..	156,398
Raw	27,101	..	29,469	..	25,501
Molasses	37,011	..	34,457	..	33,674
Molasses, manufactured (in Bond) in U.K........	19,030	..	20,262	..	20,976
Total..........................	450,916	..	427,680	..	435,026
Less Exports of British Refined................	5,879	..	5,247	..	8,320
	445,037		422,433		426,706

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, MAR. 1ST TO 31ST, COMPARED WITH PREVIOUS YEARS.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1911.
119,450	1,504,960	448,850	732,880	302,040	3,108,180

	1910.	1909.	1908.	1907.
Totals ..	..2,561,230	..2,983,620	..3,077,030	..3,181,090.

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING FEBRUARY 28TH, IN THOUSANDS OF TONS.

(Licht's Circular.)

Great Britain.	Germany.	France.	Austria-Hungary	Holland, Belgium, &c.	Total 1910-11.	Total 1909-10.	Total 1908-09.
1931	1311	722	622	235	4821	4765	4544

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1910-1911. Tons.	1909-1910. Tons.	1908-1909. Tons.	1907-1908. Tons.
Germany	2,602,000	..2,027,000	..2,082,848	..2,129,597
Austria	1,570,000	..1,257,000	..1,398,588	..1,424,657
France	740,000	.. 801,000	.. 807,059	.. 727,712
Russia	2,115,000	..1,145,000	..1,257,387	..1,410,000
Belgium	285,000	.. 250,000	.. 258,339	.. 232,352
Holland	225,000	.. 198,000	.. 214,344	.. 175,184
Other Countries .	590,000	.. 460,000	.. 525,300	.. 462,772
	8,127,000	6,138,000	6,543,865	6,562,274

THE INTERNATIONAL SUGAR JOURNAL.

No. 149. MAY, 1911. VOL. XIII.

☞ All communications to be addressed to the Editor, Office of "The Sugar Cane," Altrincham, near Manchester. All Advertisements to be sent direct.

☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

Cheques and Postal Orders to be made payable to NORMAN RODGER, Altrincham.

The Editor will be glad to consider any MSS. sent to him for insertion in this Journal and will endeavour to return the same if unsuitable; but he cannot undertake to be responsible for them unless a stamped addressed envelope is enclosed.

NOTES AND COMMENTS.

The Palm Weevil as a Sugar Cane Pest.

In a recent circular of the Trinidad Department of Agriculture, Dr. Lewis H. Gough gives some descriptive information on the Palm Weevil which has latterly been again detected as a pest on sugar canes. His attention was drawn last Autumn to some cane plants on an estate in Trinidad which were suffering from an attack of beetle grubs. The damage done was considerable, quite 25 per cent. of the plants having been killed, and many others injured or checked in their growth. Investigations showed that the canes were more or less tunnelled through by legless beetle grubs, which were identified as belonging to the Palm Weevil, *Rhynchophorus palmarum*, and locally known as Grugru Worms.

Dr. Gough however points out that Grugru Worms are among the oldest known parasites of the sugar cane, and have been repeatedly observed in various other parts of the West Indies besides Trinidad. They were first recorded as sugar cane pests in 1828 by the Rev. Lansdown Guilding. In 1847 they were observed by Sir Robert Schomburgh at Barbados, attacking recently planted cane-plants. In 1880 Miss Ormerod received specimens from sugar cane grown in British Guiana. In Trinidad it has been observed more than once as

an enemy of cane cultivation. In 1900 Mr. Hart recorded a case in a cane in the Experimental Station, St. Clair, discovered by Mr. Collens. Since then it has been reported on by Mr. Urich in his annual report for the year ending 1910 and in his monthly reports to the Board of Agriculture. It does not seem to have been re-observed in Barbados during recent years, as no record of it can be found in the *West Indian Bulletin*, nor is it mentioned in that journal in any of the list of enemies of the sugar cane.

Briefly put, the description of the pest is as follows. *The eggs:* These are elongate, with rounded ends, usually somewhat curved, white or cream-coloured objects. They measure $\frac{1}{30}$ of an inch in diameter by about 0·1 inch long. They have been known to hatch in less than 48 hours. *The larva:* This is a milky white or cream-coloured legless grub with a mahogany brown head and horny yellow anal plates. It grows to about $2\frac{1}{2}$ to 3 inches in length. *The Pupa* is clay-coloured with darker brown colour on head and antennæ, the tips of the rostrum, the margins of the thorax, tips of the legs, and on the margins of the wing sheaths. It measures about $1\frac{1}{2}$ inches long. The pupal stage lasts about 2 to 4 weeks. *The Adults* vary considerably in size, from $1\frac{1}{4}$ inches to $1\frac{3}{4}$ inches being the average. They are velvety black-coloured beetles with a long rostrum.

As to remedies, Dr. Gough points out that Bordeaux mixture is useless as a preventative, not being an insecticide. He thinks any scheme of poisoning the newly laid grubs is out of question, so that the only alternative is to devise measures to prevent eggs being laid in the cane plants. With this end in view, dipping the ends of the cane cuttings in dilute creosote or lysol, or else tarring them, is advocated as a means of preventing the deposit of eggs in the cane fibre.

Sugar Machinery in Porto Rico.

In a letter to *The Times*, a correspondent in Porto Rico refers at some length to the sugar machinery trade in that island. He points out that since the present tariff—free trade for the States and prohibitive duties for all outsiders—was enforced there by the United States the importations of sugar machinery from Great Britain have been very small and dependent on special conditions. The Germans, however, still have a good deal of trade with Porto Rico in spite of the high duties; they are the only nation that still compete to any extent with the United States there. The latest American crushing machinery in the island consists of 17-roll sets, *i.e.*, five 3-roll mills and a 2-roll crusher, the whole driven by two engines. An improvement on this is already foreshadowed in an 18-roll set, *i.e.*, six 3-roller mills with each of the first two mills having Diamond top rollers. These Diamond rolls have given excellent results, and are, all things considered, much better than a two-roll crusher.

A further improvement, says this correspondent, would be to drive these 18 rolls by one steam turbine instead of two reciprocating engines. The turbine arrangement offers no difficulty, and the saving in cost, foundations, steam, oil and attendance would be considerable. The exhaust steam in a sugar factory is used for evaporating and granulating the cane juice, and the condensations are returned to the boilers. The presence of oil in the exhaust steam from reciprocating motors is therefore very injurious. With turbines this trouble is entirely eliminated. So far as present experience goes, the most perfect sugar factory should have steam motors (turbines) for the milling and electric plants, and all other motors in or connected with the factory should be electric. A single milling set as above indicated can be constructed to work almost automatically, to handle over 2000 tons of cane per 24 hours' work, and, with canes averaging $11\frac{1}{2}$ per cent. fibre, to give an average extraction of 85 lb. of juice per 100 lb. of cane, with less attendance than usually required with plants working 300 or 400 tons of cane in the 24 hours, with an extraction of about 75 per cent.

"The largest company expects to turn out this year close on 100,000 short tons of 96 polarization sugars from three factories all connected by railway. The largest of these three factories has four sets of 14-roll mills, with a capacity of 5000 tons daily. That factory has a steam electric plant of over 2000 h.p. to supply current for the motors in the factory and the electrically-driven irrigation pumps for many miles around. The company's latest installation has only one crushing plant, consisting of five 3-roll mills and one 2-roll crusher, with a capacity of 1500 tons of cane daily. The average extraction is 85lb. of juice per 100 lb. of cane. This factory has one steam electric unit of 800 h.p. and three producer gas units of 300 h.p. each. With the exception of the mill engines nearly all the motors are electric. The current leaves the dynamos at about 320 volts, and after being transformed up to 15,000 volts is sent many miles over the fields to the irrigation pumping stations."

The Horner Wire Transmission System.

In the course of a paper submitted to the last annual meeting of the Hawaiian Sugar Planters' Association, reference was made to the Horner Wire Transmission System which has been given an extended trial at Hamakua, as a means of delivering cane from the fields to the mill. It consists of a stationary cable or series of cables supported on pulleys or other holders above the ground by two uprights and a cross bar, upon which cable the trolley hooks or carriers are hung with their load. Specific means are provided for supporting the cable-carrying pulleys so that the cable adjusts itself to the passing loaded trolley and by which the cable is prevented from being thrown off the pulleys; and also means by which the load can be transferred from

one cable to another. Originally the wire supporting pulleys were clamped rigidly to the cross bar, making a rigid bearing at this point, but as so many trolleys with their loads were thrown off, some counterweights were fitted to give a yielding support to the cable, and thus equalize the strain. The cable lines are laid on suitable gradients (ranging from 1 in 25 to 1 in 5) from fields to mill, and when suitably anchored at either end have spans varying from 75 to 1800 ft. The loads run along at speeds up to 45 miles an hour. They are prepared for transmission by a cane bundler which compresses the canes into suitable bundles weighing anything from 250 to 500 lbs. The chain is taken off at the terminal and carried back to the field to be re-filled. As to the cost, the experience of several years has shown that the various operations of transportation—gathering the cane into bundles, cleaning the field, loading on wagons and transporting by cable to the mill—cost $6·01 per ton of sugar, some of the cane being transported 3¼ miles. That figure includes the cost of construction, depreciation, and wear and tear of the plant. This sum, it may be added, is less than that stated as the cost of fluming.

The Brussels Sugar Commission.

At the half-yearly meeting of the International Sugar Commission at Brussels, in February, the chief business was the consideration of the Cuban sugar duties postponed from last Autumn. Since then the Cuban Congress had brought forward a proposal to reduce the duties—that on refined to 3 fr. 80 c., and that on raw to 5 fr. 20 cents per 100 kg. The Commission decided that the adoption of these duties would give complete satisfaction; and, after some discussion, agreed to extend the period of non-penalization of Cuban sugar to April 1st in the hopes that the Cuban Congress would by then have amended the duties. This the latter have now done, so the question is settled satisfactorily. It may be added that representatives of the Cuban Government attended on the Commission and asked for authority to appoint a delegate to the Commission and to incur the expenses of accession to the Convention. The next Session is fixed for November.

Export of Formosan Sugar to Canada.

From the *Japan Chronicle* we learn that a telegram has reached Tokyo to the effect that the Ensuiko Sugar Refining Company of Formosa has signed a contract to supply a Canadian sugar merchant at Vancouver with 16,000 bags (1,000 tons) of crude sugar as a trial consignment. The shipment is being arranged by Messrs. Suzuki & Co. of Tokyo. The export of Formosan sugar to Canada has long been talked of and has now at last been realized. The associated raw sugar producers of Formosa maintain that the extension of the market of their sugar need not necessarily be confined to China, and they

state that they will enter into competition in India too. And we suppose it will only be a step further to try the British market, now that our Government has insisted on all comers being welcomed. whether their product is bountied or not.

Société des Chimistes de Maurice.

We are pleased to notice that the chemists of Mauritius have formed themselves into a society for the purpose of unifying methods of analysis and of *sucrerie* control on the island. The newly formed society has under consideration a number of important questions, such as whether the density of the first mill juice represents that of the normal juice; methods of calculating the dilution; whether the density of the diluted juice should be taken before or after sulphitation; the best methods of sampling and preserving the different juices; and the adoption of the double polarization of the juice in place of the ordinary direct polarization. The society publishes a quarterly journal styled the *Bulletin de la Société des Chimistes de Maurice*, which has just come to hand, and to which we look in the future for some useful articles. The first two by Messrs. Giraud and de Sornay, which will be found abstracted in this issue of the *Journal*, promise well.

SUGAR IN INDIA.

I.

The history of the European beet-sugar industry during the last fifty years is a marvellous illustration of the progress—almost by leaps and bounds—which an industry can make when assisted by legislation. Such an economic system may be theoretically bad, but the fact remains that the results, so far as the industry is concerned, are excellent up to a certain point. Beyond that everything is disaster.

The artificial helps have now been removed, and we turn with interest to look at a similar uprising in the cane-sugar industry. Here again we see progress by leaps and bounds, even more prodigious than those we have witnessed in Europe. The production of cane-sugar here and there is now being artificially stimulated and its growth progresses under our eyes at an almost incredible rate. The policy of the United States Government is the main motive power of this great upheaval. They began with the Hawaiian Islands. A reciprocity treaty in 1876 admitted "Sandwich Island sugars" into the United States free of duty. The production of sugar in those islands rose from 11,640 tons in 1876 to 229,000 tons in 1898. In that year the islands were annexed to the United States, which gave the industry a fuller confidence in the future, and the production more than doubled. The best machinery, the highest farming, keen

scientific control, almost universal irrigation and, last but not least, unlimited capital are now the order of the day in that successful colony. In 1907, two of the four islands produced an average of 5·6 tons of sugar to the acre.*

Turning to Cuba we find that a much smaller preference, only 20 per cent. of the duty, has worked wonders quite as great. An enormous impetus has been given to the sugar production of that fertile island. Before the revolution and the subsequent American war with Spain, Cuba just managed to produce up to a million tons of sugar in a good year. During her troubles, the crop fell to an insignificant figure. Now, with the small preference of 1s. 6d. per cwt., she produces (in 1909-10) 1,804,349 tons of sugar. Here again, as in the Hawaiian Islands, large capital, the best machinery, and first class scientific control are all predominant. The factories are constructed on an enormous scale, and the cost of production is consequently reduced to a minimum. One factory is reported to crush 600,000 tons of cane in the season and to turn out 75,000 tons of sugar, and many others are nearly as big.

But the United States Government are not alone now in giving this encouragement to the sugar industry. That go-ahead country, Japan, is quite alive to the advantage of having prosperous industries within her borders. It is but a few years ago that she turned her attention to sugar production in her newly acquired island of Formosa. The industy there was of the most primitive kind. The Japanese took the trouble to learn how sugar should be produced in the most up-to-date style, and then proceeded to do it on a very large scale. In a marvellously short space of time—two or three years—large central factories of the most modern type were springing up in all directions, in place of the primitive methods of the ignorant native. From a few thousand tons of low-class sugar, the production increased rapidly and by the year 1908-9 amounted to 122,000 tons of first-class raw sugar. The out-turn increased to 205,000 tons in 1909-10, and is estimated at 267,000 tons for 1910-11. At first the native growers did not like the idea of so radical a change of system; but they soon found that they could earn more by simply growing canes for sale to the central factory than they used to make after going through the laborious process of extracting the juice and converting it into the black mass which they called sugar. The revolution of the industry was rapid and complete. There are now 33 central factories in

* Willett and Gray's statistical Sugar Trade Journal of March 9th, gives the following from their Hawaiian Islands correspondent:—

"The last season, 1910, is generally reported to have been the most successful ever experienced on the Islands, at least as far as yield in sugar per acre is concerned. One company reports an *average* yield of 7 27 tons of sugar per acre on all its land, with a maximum yield of 12·68 tons on one field. On the average, only 7·34 tons of cane were required to make one ton of sugar."

The Hawaiian Islands produced 462,613 tons of sugar in 1909-10, and the crop for 1910-11 is estimated at 485,000 tons.

Formosa, most of them dealing with 800 to 1,000 tons of cane per diem. More are springing up every year, and it will soon become a problem of how best to dispose of the surplus production when the refiners of Japan have absorbed all that the consumption of that country requires. The sugar enters Japan free of duty, but when its production suffices for the total supply of Japan's consumption—a crisis now imminent—something must be done to ensure that Formosan sugar shall still reap the profit of the Japanese duty. A "Japanese sugar trust" is to come to the rescue. The Formosan Sugar Companies are to agree to send only a fixed quantity of sugar to Japan, while the Japanese refiners are to undertake to import no sugar from elsewhere. The Formosans must try to find outlets in other Eastern markets for their surplus production. The Consul General at Hong Kong, says:—"Sugar production in Formosa under improved modern methods has reached a point where the profitable disposal of the crop is becoming a serious problem."

There is one more striking instance—perhaps the most striking of all—of State aided production. The island of Porto Rico, when it belonged to Spain, produced about 50,000 tons of very nice Muscovado sugar, for which long prices were occasionally paid in Mincing Lane by the grocers, the sugar being, in many cases, of a peculiarly bright yellow tint. This showed that the soil was good, the juice specially pure, and the manufacture better than in some neighbouring islands. But when Porto Rico passed into the possession of the United States all was changed. From 50,000 tons the production went up to 300,000 tons, muscovado sugar became a thing of the past, enormous central factories sprang up, the planters enjoyed an extra profit of about 7/- per cwt.,—their sugar entering the United States free of duty—and the furnishing of the sugar machinery was mostly transferred to the engineers of the United States. Germany still trades with Porto Rico, but "the British flag and British goods are rarely seen." The Engineering supplement of *The Times*, of April 19th, gives some interesting details of the latest specimens of monster sugar factories in Porto Rico. The 9 and 11-roller mills driven by one engine are being eclipsed by 17-roller mills driven by two engines. But "experience has shown that better results can be obtained by having a number of mills running tandem than by the same number of mills in two sets." They talk now of having an 18-roller set, that is, six 3 roller mills, without crushers, but with diamond top rolls to the first two mills. This large set should be driven by one steam turbine.

It would be a curious experience to visit any of the sugar producing countries here described, Hawaii, Cuba, Formosa, or Porto Rico, and then to make a little tour through the sugar producing districts of British India. With the exception of a mere handful of enterprising

people, we should find the native planter crushing and boiling just as he and his ancestors have done from time immemorial. Non-intervention in agriculture and industry is the key-note of our Government in India. The natives must be left to take their own course, and we must not hurt their feelings by telling them that they are somewhat behind the times. But events are getting too strong for us. It was all very well as long as the people of India were content to consume a black mass of sticky stuff and call it sugar. But the time came when Austria and Germany began to pour in large quantities of dry white crystallized sugar which greatly took the fancy of the consumer, in spite of his terrible suspicions as to the method of its manufacture. In 1899 the Indian Government ventured to suggest to the Home Authorities that as this sugar was receiving a heavy bounty it would be only fair to the native producer that it should be charged with a countervailing duty on its importation into India. This was neither protection nor even preference, such as has stimulated the sugar industries of Hawaii, Cuba, Formosa, and Porto Rico. On the contrary, it was a restoration of free trade, a defence against protected competition, a mere request for a fair field and no favour. The British Government approved of the policy proposed from Calcutta, but when the measure came before the House of Commons, in the Indian Tariff debate of 1899, the proposal was bitterly opposed by those who erroneously imagined that they were "the bulwarks of free trade" because they were fighting against a wicked attack on that sacred but most mistaken dogma that duties must never *never* be levied except for revenue purposes. Fortunately, Mr. Chamberlain understood the subject, made game of his opponents, and demanded that the House should once for all affirm the principle of levying a duty to countervail a bounty. His eloquence prevailed, and the measure was carried by a large majority.

But suppose it were to be suggested—with fear and trembling—that a little preference, such as has produced the great industrial revivals in Hawaii, Cuba, Formosa and Porto Rico, might, perhaps, be tried with our own sugar industries in the West Indies, Mauritius, British India and elsewhere, what would then be said by those who so erroneously opposed Free Trade in 1899? And yet the pictures of those most successful American and Japanese sugar colonies might be held up for comparison with our miserable sugar industry in British India, and we might at all events come to ponder on the contrast.

This prologue is necessary in order thoroughly to appreciate the present state of the sugar industry in British India and its future prospects, which shall be examined in a further article.

BEET SUGAR GROWING.

The Movement in the United Kingdom.

In our last issue we referred to a project to start a sugar factory in Norfolk which was being pushed by a comparative new-comer, a Dutch gentleman named Cohen, who is acting as expert adviser and manager for a syndicate. This gentleman has since given further evidence of his eminently sound views on the subject. He lately addressed a letter to the Secretary of the Norfolk Chamber of Agriculture stating what he had done to arouse interest in the project and setting forth for the interest of all concerned the terms under which he was prepared to entertain offers of roots from farmers, as well as pointing out to the latter the probable results that might be expected with ordinary good fortune by the grower of a sugar beet crop on a commercial scale. His remarks strike us as so sound and so devoid of anything approaching over sanguine expectation or speculative optimism that we think it is worth our while reproducing the bulk of his communication for the benefit of our readers in this country.

He wrote as follows:—

Dear Sir,—I beg to inform you that after the meeting of March 4th, held under the auspices of your Chamber, I have been occupied in obtaining contracts for the growing of sugar beet in 1911 and 1912 and four following years on the terms as set out in that meeting.

The results generally obtained, although of a promising character, are not up to reasonable expectations, and although I was fully prepared to meet the ordinary difficulties which always accompany any new venture with far-reaching consequences, I fail to understand why many prominent men did not come forward and assist the long-looked-for scheme, viz., to get in 1912 at least one sugar factory started in Norfolk. In 1910 a large number of prominent and far-seeing men were fully convinced that a good part of the £20,000,000 consumed for imported sugar annually in Great Britain could be grown and manufactured in the United Kingdom itself. In 1911 it looks as if farming conditions are of such a prosperous nature that the ordinary routine of farming life and the growing of mangolds, swedes, and other root crops seem to be more profitable for the majority of the farmers than the growing of sugar beet. I should be the last man in the world to impress upon anybody to leave a sure and profitable source of revenue for some new venture which might be risky and hazardous, but as the growing and industry of sugar beet is so universally known and has replaced with considerable profit to the landowner and farmer the old-fashioned ways of farming, I do not need to enter here in any praise of sugar beet growing.

All that is needed is to bring under the notice of your Chamber, which is so interested in the sugar beet problem, and anxious that works should be started in Norfolk, the fact that in response to some reasonable remarks made to me with regard to some confusion made by offering a figure of 20s. per ton for beet, free at harbour, I have altered this figure to 18s. 6d. per ton to be delivered free on rail or in lighter or wherry, and that I shall myself pay freight to harbour of shipping in 1911.

In the contracts of 1912, &c., I have altered the period of contracting of five years into one of three years only, offering a higher price for the beet. Instead of 20s., I offer now 21s. 6d. per ton free works, or 20s. on rail, charging those who sell free rail with the excess freight beyond 1s. 6d. per ton. Besides there are now some better conditions for the growers in the contract, in which please find enclosed a specimen.

As the time of sowing the seed for 1911 has now arrived, and my expert will arrive here in the middle of next week, I cannot do too much to impress upon anybody who intends to grow in 1912 on a large scale, that he must remain in training during this year, and grow as much as possible. For this purpose, and with regard to my arrangements for freight and shipping, which make it indispensable that I obtain this year a good quantity of beet, I should feel obliged if your Chamber would bring to the notice of its members and the public at large that I am willing to guarantee a profit of at least £3 per acre to those who will grow in 1911 plots of 25 acres or more. This means that I guarantee a revenue of £12 per acre, assuming that the cost of production and delivery to rail or water are not more than the normal figure of £9 per acre. The revenue will be, however, higher where I could be assured that at least 15 tons per acre will be grown on ground approved of by my expert. Including £1 as the value of leaves and tops left on the field the nett profit should be £5 17s. 6d. per acre at a price of 18s. 6d. per ton. I give further free seed and seeding, and my assistance in obtaining the extra labour for the lifting and cutting of the crop.

I had formerly agreed to guarantee that this labour should not cost more than 25s. per acre, but as it is brought to my knowledge that remarks were made that this was considered to be "foreign and sweated" labour, I decline to interfere any further than by supplying this labour if required to the growers of 25 acres or more. I may be allowed, however, to state that these kind of remarks, besides doing a good deal of harm, are utterly out of the question. I intended to bring over from the Continent farm hands accustomed to this class of work, and to get from the cities here, where there are so many unemployed at that period of the year, the bulk of the labour, it taking only a few days to teach the work to the most unskilled hand. As seven pairs of hands are ample to work an acre per day, I should suggest that wages of 3s. 6d. per day are not so bad. I, however, will not further interfere, as stated.

I am further willing to supply in 1911 every grower of a certain extent with sugar-pulp (dried) guaranteed to contain 30 per cent. of sugar at the same price as it is sold to the farmers in Holland, who are growers of beet, viz., £6 10s. per ton. I will sell this at the same price f.o.b. Harwich, so that any grower who fears he will not have fodder if he grows beet instead of his ordinary roots, will not only have his fodder, but will have a fodder considerably better than any which he may be accustomed to give his cattle, sheep, horses, or pigs.

It is of no use to say, as so many have written to me, that they will grow if the work is started in 1912. The work certainly will be started in 1912, but before that I must know how many acres I can depend upon. For this purpose I did all I could on my part. I guaranteed a certain profit. If now the Norfolk landowners and growers do not come freely forward, it will not be my fault that the works will not be started in 1912, as expected.

Up to now, I have the names of 30 gentlemen, who will grow this year, and for 1912, whilst correspondence is going on with some fifteen more who are not quite decided. The largest contract embraces 40 acres for 1912 and 20 for 1911, whilst another has just arranged the reverse—40 acres in 1911 and 20 in 1912 and following years.

I should feel obliged if landowners and farmers would not attach too much weight to their own experiments made up till now, and would suspend their conclusions until after this year. If they intend to grow in 1911, no time must be lost, as the seed ought to be in the ground during this month. I have seed enough at my disposal to supply anyone who seriously wishes that Norfolk shall have its sugar factory in 1912.

E. S. ALI COHEN.

Royal Hotel, Norwich, April 1st, 1911.
To J. B. Forrester, Esq.,
Secretary of Norfolk Chamber of Agriculture.

The British Beet Council.—An important meeting of the National Sugar Beet Council was held on the 19th inst., at the offices, 1 & 2, Orchard Street, Westminster, S.W., to consider amongst other matters a communication from the Development Commission relative to a grant from their funds towards the work of the Council. The Earl of Denbigh on taking the chair explained what had occurred since the application by the Council, in September last, for a grant. It will be remembered that when Lord Denbigh raised this question in the House of Lords last February, neither Lord Crewe nor Lord Carrington held out any hopes for a grant being recommended, consequently Lord Denbigh prominently identified himself with a commercial undertaking called the "National Sugar Beet Association Ltd." In these circumstances he suggested that it would be best for him to resign the position of President of the National Sugar Beet Council, whereupon Mr. G. L. Courthope, M.P. was unanimously elected to the chair, which Lord Denbigh at once vacated in his favour, and a vote of thanks to his Lordship for his past work in the interests of the Council was carried unanimously. Mr. B. Stanier, M.P., was then elected as Vice-Chairman.

In view of the fact that the National Sugar Beet Council is a purely educational and propagandist body, and in no sense a "commercial undertaking trading for profit," it became desirable to distinguish it as clearly as possible from the newly registered National Sugar Beet Association Ltd., and to this end it was resolved to change the name to the *British Sugar Beet Council.*

It was further resolved that Mr. Courthope should appear before the Development Commissioners in accordance with their request that a witness should attend and give evidence in connection with the Council's application for a grant.

If the Development Commissioners decide to make the grant to the British Sugar Beet Council, it is intended to continue the work, which

was begun last year, of advising growers of sugar beet, inspecting the raising of the crops, and ensuring proper analyses of the roots. As, however, the Council only came into being late in the last season and its funds were extremely limited, they were only able to carry out their intention in a perfunctory way and much valuable information was unrecorded and consequently lost. There are many other fields of activity open to the Council and a comprehensive scheme was laid before the Development Commissioners by Mr. Courthope last week.

It is hoped that all those who have sown, or are intending to sow sugar beet this year, more especially in plots of one acre and upwards, will give an intimation to the Secretary at the earliest moment. Growers are reminded that the season for sowing is advancing and this work should be completed at the latest before the end of April.

The National Sugar Beet Association Ltd., referred to above, was registered on April 1st, with a capital of £25,000 in £1 shares, with the object of promoting and extending the cultivation of sugar beet in the United Kingdom. The Directors are Lord Denbigh (Chairman), J. W. Dennis, J. R. Drake, Captain J. A. Morrison, M.P., and G. Pauling. The office of the Company is located at 19, Abingdon Street, Westminster.

THE SUGAR BEET.*

Its Mode of Cultivation and Development.

By Ed. Koppeschaar.

(Continued from page 188.)

Of the other commercial nitrogen fertilizers, sulphate of ammonia, is an excellent rapidly-acting agent. The 20 to 21 per cent. nitrogen it contains is rapidly nitrified and in that form brought within reach of the plant roots, especially when the soil contains enough lime. Experiments† with sulphate of ammonia have proved that this fertilizer, of which England produces about 177,000 tons per annum, is well worth placing on the list of those from which a choice be made. Poisonous ingredients, such as cyanogen compounds, need no longer be feared, since the industry knows how to produce this by-product free from them. Sulphate of ammonia works a little slower than Chili saltpetre; but at the same time it is not so easily washed out as this latter. We may say it does not force so well as Chili, but its beneficial influence for the plant lasts longer.

The need of phosphoric acid we dwelt on at some length in the first chapter. Easily available phosphoric acid is what is needed. To supply

 † By Aitken.

this to our beets a fairly long list of natural as well as artificial fertilizers is at hand to select from. Repeated experience has proved that plenty of phosphoric acid within easy reach of the plant at the time of its most active vegetation (when germinating and when quite young) is a question of necessity, in order to produce a good crop of rich sugar beets. Hence, especially after green manuring, extra phosphoric acid has to be supplied, as the plants seem to be unable to utilize the phosphoric acid brought into the soil by the green manure. Thomas-slag, especially if it can be obtained with a high percentage of citrate-soluble phosphoric acid, does good service in lighter soils.

In regard to potash fertilizers, as already remarked, experimental plots should decide the matter for the farmer. It may be said, though, that in general, high percentaged salts are preferred, and these should be applied in the fall. Salts containing 40 per cent. potash do not cause the soil to crush so much, and the purity of the juice in the beets does not in any way suffer from them. Besides, these concentrated salts cost less in transport and so may be sold cheaper.

Standing in close relation with sugar production is a by-product that deserves mention; it contains about 10 per cent. potash (K_2O) and about 3 per cent. nitrogen. It is the by-product from distilleries containing the potash originating from the molasses, in fact the greater part of the potash present in the beets.

When applying commercial fertilizers, it is not superfluous to bear in mind that some of them do not stand mixing with each other. Thus ammonia salts should not be mixed with Thomas-slag or quicklime, for *quicklime* + *sulphate of ammonia* = *gypsum* + *water* + *ammonia*. The ammonia formed will soon escape into the air and its nitrogen be lost. Lime as contained in lime-cake, in the form of carbonate, does not have this effect; on the contrary, it will cause the ammonia salt to have as much effect as Chili saltpetre, *i.e.*, *lime-carbonate* + *sulphate of ammonia* = *gypsum* + *carbonate of ammonia*. Besides, the free ammonia hinders the vegetative conditions of the nitrifying bacteria, while carbonate of ammonia is readily taken up by them in order to form saltpetre from them. Superphosphate should not be mixed with quicklime as losses of soluble phosphoric acid would occur, tricalcium-phosphate being formed, which is insoluble on limed soils; therefore one will do better to take Thomas-slag instead, which is not affected by lime. Mixing Chili saltpetre with superphosphate cannot be recommended, unless at the last moment just before it is sown, and the superphosphate is dry. Thomas-slag and potash salts stand mixing with each other before sowing. As to the new nitrogen fertilizers, Norwegian-saltpetre and lime-nitrogen (nitro-lime), we have already referred to these.

These articles being written to give information to farmers in regard to all those details which may be of use when embarking on the new cultivation, there is one item still worth drawing their attention to, as it is a question of importance where the establishment of a factory is seriously contemplated.

As may be generally known, the sugar in the beet is extracted in a battery of iron cells, in which the sugar from the shredded beets dissolves out into the surrounding water; extracting the dry sugar from this raw juice means evaporation plants and boiling pans, the vapours of which are condensed again by the aid of an air pump and cold water. Water therefore is a necessity for a beet sugar factory. The water that is destined to extract the sugar may contain some impurities. If choice is to be had, of course the purest will be taken. The amount of this water is determined by the juice drawn off: 100 to 110 litres per 100 kilos. of beets (or 11 to 12 gallons per cwt.). Besides this water, which is destined to become raw juice, about 100 per cent. of beet weight is needed for the battery, which water leaves the battery again together with the pulp; this latter 100 per cent. constitutes part of the waste water of a sugar factory. A far larger quantity is needed for condensing the vapours from boiling pans and the evaporators. For a 1000-ton factory this amounts to 5000 to 6000 kilos. (1100 gallons to 1300 gallons) per minute. Together with the water used to wash away the pulp from the battery cells, and that used to wash and cool the carbonic acid gas and various wash-waters, the quantity needed will amount to 6 to 8 cubic metres per minute (1330 to 1750 gallons) for a 1000-ton sugar factory. However desirable this may be, not every factory is so well situated to be able to supply such a quantity fresh, in which case resort must be had to means for purifying part of the water used, and using it over again.

The disposal of the waste waters,* proportionately large, should be considered as well, and measures be taken to divide the waste waters and, by proper additions of lime and an iron salt, reduce the nuisance they cause, as well as the complaints aroused by them, to a minimum. The waste water from the battery (including the water pressed out from the pulp) should be treated separately. If properly limed a heavy fermentation will set in, causing most impurities to be split up into gaseous substances (the sugar into water and carbonic acid gas, the nitrogenous substances into ammonia gas and nitric acid), which process is accompanied by the formation of a thick layer of foam on the surface. The wash-water from the beets, containing the adhering dirt and sand, is best kept separate also and led into settling basins.

The difference between these waste waters will be seen from the following data relating to some samples the writer took personally:—

*It may be emphasized here that the waste waters of a sugar factory never contain any disease germs.

	$KMnO_4$* mgrms. per litre.		Solid substance mgrms. per litre.		Suspended matter, mgrms. per litre.		Loss on ignition mgrms. per litre.
Original fresh water from river	44·2	..	—	..	—	..	—
Wash water	726·8	..	5050	..	4515	..	4525†
Battery water	3091	..	2810	..	1425‡	..	660
Cleaned waste water returned to river..	189·6	..	—	..	—	..	—

In regard to selecting a site for a sugar factory, and the area needed, in addition to what has been remarked about the settling basins and the proper separation of the waste waters, it must be remembered that where transport by water is cheaper in general than by rail, a large water front as well as rail connection will be desirable. Not only will beets have to be transported, but, as a raw sugar factory consumes about 6 to 8 per cent. coal and about 5 per cent. of limestone per beet weight, transport costs will form a large item in the costs of production. For coal, limestone, lime-cake, &c., sufficient storage space must of course be available.

Having by now reached the conclusion of his articles, destined in the main for beginners, the writer ventures to express the hope that the painstaking experiments of pioneers like Lord Denbigh and others, and the impartial information brought within reach of interested parties by the press—both lay and technical—may lead to a changed state of affairs regarding the production of sugar in the United Kingdom. That men are indeed to be found who maintain that the British Isles are unfit for the growing of sugar beets, reminds one that years ago a financial syndicate sent out some experts to the Western States of America, who on their return reported that the soil did not seem fit to carry on beet growing on a large scale. In these same Western States nowadays the richest beets are cultivated, while for all the States the following estimate is given for 1910 (*Amer. S. Ind.*, *B. S. Gaz.*):—

	Factories in operation.		Estimated yield of beets in short tons (2000 lbs.)		Do. sugar.
California	8	..	927,000	..	142,423
Colorado..	13	..	806,000	..	98,000
Idaho	3	..	120,000	..	15,000
Michigan	17	..	1,079,600	..	139,200
Nebraska	2	..	87,000	..	10,440
Ohio	2	..	109,000	..	12,050
Utah	5	..	310,000	..	36,800
Wisconsin	4	..	170,000	..	20,500
Arizona, Illinois, Iowa, Kansas, Minnesota, Montana, Oregon, Washington	7	..	328,255	..	37,503
	61		3,936,655		511,916

* Potassium permanganate: its percentage is a measure of the organic substance.

† The larger part of this is earth and sand.

‡ To a large extent cellulose.

Taking into account the fact that some 20 years ago practically no beet industry existed in the United States, this shows what can be accomplished in a comparatively short lapse of time.

To the farmers who contemplate following the example of their American cousins we would point to the fact that while of course they should receive remuneration for their labour bestowed on this new crop, there is an indirect source of profit that should not be overlooked. It is apparent that the extra cultivation, draining, weeding, and fertilizing, and the well-studied rotations will also benefit equally their other crops. Studies in this direction have been made and figures have been published, but farmers will themselves understand that extensive cultivation will profit their farm as a whole. That the gains from the by-products, leaves, tops, pulp, lime-cake, will do their share towards spreading the cultivation we do not doubt.

As to the general economic desirability of this cultivation, one can point to the fact that when most of the farm work is finished, the beet harvest requires help well into the late fall. Although the benefits accruing to engineers, builders, contractors, and merchants, &c., do not lie within the scope of these articles, we may at least point to the fact that the establishment of a well-managed beet sugar factory means a steady normal source of prosperity to the community that has it within its limits.

CALCULATIONS RELATING TO A HEATING, QUADRUPLE EFFECT EVAPORATING AND VACUUM BOILING INSTALLATION FOR A SUGAR FACTORY.*

By Francis Maxwell
(Grad. Swiss Federal Polytechnicum; Sugar Chemist, Brunswick), Sydenham, London.

(Continued from page 624.)

II.

VACUUM BOILING PANS.

According to the preceding notes on "Evaporation," the quantity of concentrated juice or syrup to be treated per hour in the vacuum boiling plant under consideration is:

$$D = 12505 \text{ kg. per hour.}$$

In concentrating this amount of syrup from $B_4 = 60$ Brix up to say $Bm_1 = 94$ Brix, the corresponding quantity of first product

* The following calculations refer to a complete Juice Heating, Quadruple Effect Evaporating and Vacuum Boiling Installation, manufactured by The Sugar Machinery Manufacturing Company, London, which has recently been shipped abroad, to the order of a well-known Continental firm.

massecuite hourly produced may be determined from the following equation :—

Equation XVII. : $P_1 = D \frac{B_4}{Bm_1}$

Substituting:

$$P_1 = 12505 \frac{60}{94} = 7982 \text{ kg. per hour}$$

or 191568 kg. of first massecuite per 24 hours.

Therefore the water to be evaporated per hour in the first product pans is:

$$W_1 = D - P_1$$
$$= 12505 - 7982 = 4523 \text{ kg. per hour.}$$

CONSUMPTION OF HEAT AND STEAM IN THE FIRST PRODUCT PANS.

The temperature prevailing in these pans we assume to be 65° C. The syrup, which enters the pan at a temperature of say 65° C., is boiled to massecuite of 94 Brix, and then, immediately before discharging, the strike is usually heated to about 75° C., to facilitate its discharge from the pan.

In order to determine the consumption of heat, it is necessary to know the specific heat of the syrup on entering, and that of the massecuite on leaving, the pan.

These values may be calculated according to the Equation Va evolved in the preceding section on the Quadruple Effect (this *Jl.*, 1910, 566):

$$C = \frac{(100 - B)Cs + Cm.\,B.t.}{100 \times t}$$

in which:

For the syrup	For the massecuite
$B_4 = 60$ Brix.	$Bm_1 = 94$ Brix.
$t_1 = 65°$ C.	$t_2 = 75°$ C.
$Cs_1 = 65{\cdot}157$ calories.	$Cs_2 = 75{\cdot}239$ calories.
$Cm_1 = 0{\cdot}3391$ calories.	$Cm_2 = 0{\cdot}34009$ calories.

These values substituted in the above equation give :—

$$C_1 = \frac{(100 - 60)\,65{\cdot}157 + 0{\cdot}3391 \times 60 \times 65}{100 \times 65}$$
$$= \frac{2606{\cdot}3 + 1322{\cdot}5}{6500} = 0{\cdot}6044$$
$$C_2 = \frac{(100 - 94)\,75{\cdot}239 + 0{\cdot}34009 \times 94 \times 75}{100 \times 75}$$
$$= \frac{451{\cdot}4 + 397{\cdot}6}{7500} = 0{\cdot}38$$

For the determination of the amount of heat required per hour to concentrate the syrup from 60 Brix at 65°C. to massecuite of 94 Brix at 75°C. in the first product pans, we evolve the following equation :—

Equation XIX. :

$$D.C_1.t_1 + S.Ct = P_1.C_2.t_2 + W_1Ct_1 + S.Cs + L_1$$

in which all symbols are known, except S, the amount of heating steam, C_t its corresponding total heat, C_s the sensible heat, and L_1 the heat lost by radiation.

The above equation is evolved from the axiom that the total amount of heat entering the pan is equal to the sum of the various amounts of heat leaving the pan. The quantities are :—

$D.C_1.t_1 =$	Heat contained in the	syrup entering the pan,
$S.Ct =$	,, ,,	steam entering the calandria,
$P_1.C_2.t_2 =$	,, ,,	massecuite leaving the pan,
$W_1.Ct_1 =$	,, ,,	vapour leaving the pan,
$S.Cs =$	,, ,,	condensed water leaving the calandria,
and $L_1 =$	heat lost by radiation.	

Since the total heat of the heating steam minus its sensible heat is equal to the latent heat of the heating steam entering the calandria of the pan, by transforming the above equation we obtain :—

Equation XX.: $S.C_l = P_1C_2.t_2 + W_1.Ct_1 + L_1. - D.C_1.t_1$

from which we are able to determine the amount of steam necessary to produce the required heat, thus :—

Equation XXI.: $$S = \frac{P_1C_2.t_2 + W_1.Ct_1 + L_1 - D.C_1.t_1}{C_l}.$$

The loss of heat due to radiation, per hour per square metre, for a vacuum pan 3 m. diameter and 5 m. high, with 35° C. temperature difference between the pan and the surrounding air, we may take, according to Péclet's experiments, to be approximately :

$$M_l = 94 \text{ calories.}$$

The exposed surface of the pan being about 70 square metres, we find the total loss of heat due to radiation per hour to be—

$$L_l = 70 \times 94 = 6580 \text{ calories.}$$

Knowing the values of all symbols used in equation XX., including C_t, which, according to Zeuner's table, is $C_t = 626{\cdot}33$ calories, we can proceed to determine the total amount of heat required per hour, thus :—

$$SC_l = 4523 \times 626{\cdot}33 + 7982 \times 0{\cdot}38 \times 75 - 12505 \times 0{\cdot}6044 \times 65 + 6580$$
$$= 2832890 + 227487 - 491270 + 6580$$
$$= 2575687 \text{ calories per hour.}$$

Assuming that these calories are supplied by exhaust steam at a pressure of 1·5 atmospheres, corresponding to a temperature of 112°C. and a latent heat of 528 calories, the amount of heating steam required per hour, according to equation XXI is :—

$$S = \frac{2575687}{528} = 4878 \text{ kg. per hour.}$$

CONSUMPTION OF HEAT AND STEAM IN THE AFTER-PRODUCT PAN.

If we assume that 70 per cent. of the first massecuite is turned into sugar crystals, the amount of molasses separated from the crystallized sugar per hour is 30 per cent. of 7982 kg. or

$$M_2^1 = 2395 \text{ kg. per hour.}$$

Let us further assume that the density of the molasses, after being diluted with water prior to undergoing sulphuration and filtration, is $B^1mol = 60$ Brix. The original density of the molasses being about $Bmol = 80$ Brix, the total amount of diluted molasses to be treated per hour in the after-product pan is:—

$$M_2 = M_2^1 \frac{Bmol}{B^1mol} = 2395 \times \frac{80}{60} = 3193 \text{ kg. per hour.}$$

Upon concentrating this quantity of molasses in the after-product pan to a density of, say, $B_{m_2} = 90$ Brix, the quantity of the second massecuite produced amounts to—

$$P_2 = M_2 \frac{B^1mol}{B_{m_2}} = 3193 \frac{60}{90} = 2128 \text{ kg. per hour.}$$

and the corresponding quantity of water evaporated:

$$W_2 = M_2 - P_2 = 1065 \text{ kg. per hour.}$$

The temperature prevailing in the after-product pan we may take to be 60° C., and that of the molasses entering the pan 35° C. Before emptying the pan, the strike is generally heated to about 80° C.

The amount of heat required per hour in the pan is determined in a similar manner to that employed for the first-product pans, in which way we obtain—

Equation XXII.: $S_1 C_l^1 = P_2 C_2^1 t_2^1 + W_2 Ct_2 + L_2 - M_2 C_1^1 t_1^1,$
from which

Equation XXIII.: $$S_1 = \frac{P_2 C_2^1 t_2^1 + W_2 Ct_2 + L_2 - M_2 C_1^1 t_1^1}{C_l^1}.$$

The values of Ct_2, C_1^1, C_2^1, and L_2 are found in the same way as before, and $Ct_2 = 624{\cdot}8$ calories (from Zeuner's table).

According to equation V^a^., the specific heat of the molasses is—

$$C_1^1 = \frac{(100 - 60)\ 35{\cdot}037 + 0{\cdot}3367 \times 60 \times 35}{100 \times 35}.$$

$$C_1^1 = \frac{1401{\cdot}5 + 707}{3500} = 0{\cdot}602$$

The specific heat of the second massecuite:

$$C_2^1 = \frac{(100 - 90)80{\cdot}29 + 0{\cdot}34062 \times 90 \times 80}{100 \times 80}$$

$$C_2^1 = \frac{802{\cdot}9 + 2452{\cdot}5}{8000} = 0{\cdot}407$$

According to Péclet: $L_2 = 5370$ calories.

Substituting the values of the symbols, the Equation XXII. becomes:

$$\begin{aligned} S_1 C_l^1 &= 2128 \times 0{\cdot}407 \times 80 + 1065 \times 624{\cdot}8 + 5370 - 3193 \times 0{\cdot}602 \times 35 \\ &= 69287 + 665412 + 5370 - 67276 \\ &= 672793 \text{ calories per hour.} \end{aligned}$$

The corresponding amount of steam required to produce this heat is:

$$S_1 = \frac{672793}{528} = 1274 \text{ kg. per hour.}$$

SIZE OF VACUUM PANS.

The size of vacuum pans depends mainly upon the length of time required for graining. In most modern cane sugar factories the completion of a strike, including filling and discharging, may usually be depended upon in nine hours. We have previously found that the amount of first massecuite produced per 24 hours is 191568 kg., which, taking the density of the mass of 1·53, corresponds to about 1252 hectolitres. Consequently the requisite capacity of the pans is $\frac{1252 \times 9}{24} = 470$ hectolitres, hence two first product pans, each of 250 hectolitres working capacity, are ample.

The capacity of the low-product pan under consideration is based upon the amount of $24 \times 2128 = 51{,}072$ kg. of second massecuite per 24 hours or assuming a density of 1·53, this means a total capacity of 334 hectolitres. Taking a graining period of about 18 hours, we find $\frac{334 \times 18}{24} = 250$, or that one after-product pan of 250 hectolitres capacity is ample.

AREA OF HEATING SURFACE.

In a multiple evaporating effect, owing to the shallow depth of the juice admitted, the hydrostatic pressure only plays an insignificant part; but this factor has quite an appreciable effect upon the efficiency of the heating surface of a vacuum pan.

The greater the height of the liquid column resting upon the heating surface, the greater will be the pressure, and therefore the temperature, of the lower layers of the boiling mass. This factor naturally causes a decrease in the mean temperature difference between the heating steam and the heated mass, therefore lowering the efficiency of the heating surface.

Similarly the condition for both the heat transmission and the boiling point of sugar solutions of different sugar content vary considerably at different periods of the boiling process. To elaborate these points would be beyond the scope of this article.

Confining ourselves to results obtained in practice, we may assume the average temperature of the boiling mass resting upon the heating surface at about 80° C., and, according to experiments conducted by Claassen and Jelinek, the average coefficient of heat transmission for first-product pans is approximately $K_1 = 600$ calories per hour per square metre, and for low-product pans $K_2 = 300$ calories per hour per square metre.

We can now proceed to calculate the approximate heating surface required, according to equation XV., evolved in the preceding chapter on "Evaporation" (this *Jl.*, 1910, 623).

For the first-product pans:—

$$H_1 = \frac{Sc_l}{K_1 (T - t)} = \frac{2575687}{600 (112 - 80)} = 134 \text{ square metres.}$$

For the second-product pan:

$$H_2 = \frac{672793}{300\ (112 - 80)} = 70 \text{ square metres.}$$

The makers of these vacuum pans have however given a heating surface of 100 square metres to each pan, on constructional grounds, and for the following practical reasons:—

i. To allow of a lower mean pressure of heating steam than $1\frac{1}{2}$ atmos. to be used.

ii. To allow for lime incrustation of the heating tubes.

iii. To ensure a margin of capacity to cope with any sudden overload.

FRANCIS MAXWELL.

THE GUANICA CENTRAL, PORTO RICO.

Guanica Central Factory, which is the property of the South Porto Rico Sugar Company, is situated on the southern side of that island, and its operations extend from Mayaguez, on the western side, to Amelia, an estate about 10 miles east of Ponce, on the eastern side, that is, a distance of about 80 miles. The factory is near the middle of the district, being 40 miles from Mayaguez and 40 miles from Amelia. The canes are taken to the factory mainly by the American Railway Company's line; in addition, the South Porto Rico Sugar Company possesses about 13 miles of a similar gauge (1 metre) to that of the American Railway Company.

On each estate are loading stations at which the canes are weighed; they are taken to the loading stations by trucks drawn by oxen, running on permanent and portable tram lines, and by ox carts. Each cane wagon holds from 15 to 18 tons of clean canes, and is divided into two compartments. During the day and night, Sunday included when necessary, these wagons are collected and taken to the factory by the railway engines. On the funnels of these engines a special form of mushroom-shaped spark-arrester is attached, to prevent the ignition by sparks of the fields of sugar canes along the line. Some of these engines take to the factory at one time as many as 450 tons of cane. At the factory a small locomotive is kept for removing the empty wagons and putting filled ones into their places.

In addition to a number of estates belonging to the company and leased by it, from which something like 1000 acres is cropped, canes are purchased from independent growers, known as colonos, or, as they would be termed in the British West Indian Islands, cane farmers. These colonos, as well as the estates which are worked separately from the factory, are credited with from $5\frac{1}{2}$ to 6 per cent. of the weight of the sugar extracted from the canes, according to the quality of the juice, and paid for on its value in the New York market at the time of its manufacture.

The wagons containing the canes are drawn one at a time into the mill house by a cable attached to a drum of an electric winch. Chains suspended from a strong beam are passed along the inside of the wagons, across the bottoms under the canes and hitched at the side. The canes are then hoisted by an electric winch attached to a travelling crane snspended over the wagon. While it is thus suspended, the weight of each half car-load is recorded automatically on a ticket inserted into a slot in the weighing machine. The crane is then run over a hopper, and discharged by means of a lever which liberates the hitches in the chains. Along one side of the hopper an elevator, having curved iron rods on it, takes the canes to the crusher before the mill. There are four of these mills, and for the purpose of keeping an accurate account of their work, extraction, &c., they are designated A, B, C, and D. A is a Fulton Ironworks Cora, 78-inch by 34-inch twelve-roller mill, with crusher. B is a 72-inch by 37-inch six-roller mill, with crusher; it is only used when more canes are received than the three other mills can crush. C is an 84-inch by 34-inch twelve-roller mill, with crusher; and D is a duplicate of A, that is, a Fulton Ironworks Cora, 78-inch by 34-inch twelve-roller mill, with crusher. All the mills have hydraulic pressure, acting on the top rollers. Water is used for maceration before the feed rollers of the second, third, and fourth mills, and amounts, on the average, to 20 per cent. of the weight of the juice.

The extraction of the juice in the canes, under these conditions, when the six-roller mill was not in use, was from 84 to 86 per cent. of the weight of the canes. The mixed juice from the mills passes through what is called a double-decked strainer. Along the surface of each strainer a scraper elevator runs, removing the particles of fine megass, &c., and dumping them on the megass between the second and third mills. From the end of the strainer the juice is sent by a bucket elevator to eight weighing tanks, which are six feet in diameter and contain, on the average, about 4000 lbs. of juice. In order that an accurate check may be kept on the results of the crushing of the mills, the tanks are filled with water and weighed daily, so as to ascertain that the scales are recording correctly. The cane scales are also checked every day by means of an unused mill roller of known weight, which is kept on a truck, so that it may be run beneath each scale and weighed. Analyses are being made continually, and every morning the head of each department makes a return to the general manager of the result of the previous twenty-four hours' working, so that at the beginning of each day that officer has in his possession the weight of the canes, the weight of the juice and the average analyses of the juice and megass made every four hours for the past twenty-four hours; he can therefore see at a glance whether the mills are extracting the highest possible quantity of juice from the canes, and is in possession of other useful information necessary to the provision of complete control.

Towards the end of the last reaping season, as an experiment, the megass from one of the 12-roller mills was macerated and passed through the last three rollers of the adjoining mill, and an extra 2 per cent. on the weight of the cane, in juice, was obtained. In consequence of this, the Company, which has recently purchased the Fortuna factory, is at present installing there a 15-roller mill, with crusher. It may be mentioned here that at Fortuna factory the Naudet process was formerly in use, but the machinery for this is now being discarded so as to make room for ordinary multiple mills.

From the weighing tanks, the mixed juice is pumped to the liming tanks. On its way to these, milk of lime is run in at the rate of 1 lb. of lime to a ton of canes, and by means of a small pump a stream of the limed juice passes in an open gutter in front of an operator, who with a solution of phenolphthalein, contained in a large glass receiver, ascertains whether the juice is sufficiently limed, by dropping a small quantity of the indicator into the limed juice as it passes before him. In the event of the juice needing more lime, by opening a cock he increases the quantity, and if he finds it is too great, by partially closing the cock decreases it. After the juice is limed it passes to Deming horizontal superheaters, kept at 220° F., and is run from these into absorbers, where the gases and air included in the juice escape through a pipe inserted in the top of the vessel. These hot gases are used for heating the juice that comes from the filter presses.

From the eliminators the juice passes to six Deming separators. These are cylindrical vessels, cone-shaped at the basal end; four of them have a capacity of 12,000 gallons, and two of 10,000 gallons each. The settlings from these separators are drawn off every 20 minutes, and run into tanks, where, by means of cocks at various heights along the sides of the tanks, the clear juice is withdrawn. The residue is run into separate tanks, and after 50 per cent. of water is added, is thoroughly mixed, steamed, and passed through a range of 34 filter presses. The clear juice from the Deming separators is sent to the Lillie quadruple evaporators, of which there are three, capable of evaporating 40,000 gallons of mixed juice each, to syrup of 28° to 30° Bé., in 24 hours. In addition to the Lillie evaporators, there has been recently installed a Kestner climbing film evaporator.

From the evaporators, the juice is pumped into tanks, whence it is drawn by the vacuum pans, of which there are six, two 12½ ft. in diameter, and four 12 ft. in diameter. Each part contains, when fully charged with massecuite, sufficient to yield about 27 tons of dried sugar per strike. The massecuite from the pans is discharged into the crystallizers, and allowed to remain for five hours; it is then run into pug mills, and on to the electrically-driven centrifugals, of which there are 33. These run at the rate of 1000 revolutions per minute. The molasses from the first sugar is re-boiled; this is done by first

graining the pan with syrup, and then the molasses, which has been diluted with hot water to 30° Béaume, is taken into the pan as required. If possible, this is boiled eight hours, and then discharged into crystallizers, where it remains for about six days.

The crystallizers are circular vessels, 19¼ ft. long × 9 ft. in diameter; inside of them there are revolving fans, and they are jacketed for steam or cold water. It is estimated that 10 ft. of crystallizer space is sufficient per ton of cane crushed per day. As the sugar leaves the crystallizers it is mixed, by means of an Archimedean screw conveyor, with the first sugars, and taken by a bucket elevator to a receiver, whence it is run into bags resting on small platform scales, weighed sewn up, and taken to an elevator which conveys it to the sugar store, whence it is shipped direct to vessels, by means of a tram line of about 300 yards.

The mixed sugars have an average polarization of 96°, the first sugar being 97° and the sugar molasses 94°. The molasses from the second sugars, of which there remains about 65 gallons per ton of sugar, is pumped into large tanks, and taken by tank steamers to the United States for the purpose of making whiskey. The purity of the residual molasses is about 28 per cent.

With regard to the land supplying canes to the factory, at present there are something like 11,000 acres of canes grown by the South Porto Rico Sugar Company on its own account, in addition to the canes obtained from a large number of colonos. On most estates there is an admirable system of irrigation. At some of the pumping stations, petrol engines are used for the motive power; at others, particularly those in the neighbourhood of the factory, the pumps are operated by electricity. This is generated at the sugar factory and conveyed by cables to the various stations. Where there is not sufficient rainfall, an effort is made to supply each acre of canes with 50,000 gallons of water every ten days.

The land is almost in every instance either prepared by steam, or bullock-drawn ploughs. Where the steam ploughs are to be used, as soon as the canes are cut, the fallen leaves are burnt and the land is immediately ploughed, harrowed, and then, by means of double mould-board ploughs, furrowed. The canes are planted in the bottoms of the furrows about 2 ft. 6 in. apart, the cuttings being similar to those used in Barbados; the water, where they are irrigated, is then run along the furrows. As soon as the young canes are about 18 in. to 2 ft. high, chemical fertilizers are strewn on each side of the clumps, and a small plough drawn by a mule is used to throw some of the soil from the banks on to the stools. Until the canes are too advanced to prevent their use, cultivators are worked on the banks, in order to keep the fields, as far as possible, free from weeds.

THE BACTERIAL DETERIORATION OF SUGARS.

By Wm. L. Owen, B.S.,

Bacteriologist of the Agricultural Experimental Station of the Louisiana State University.

Introduction.

The question of the deterioration of sugars in storage has formed the subject of many investigations both in the cane and beet sugar industries in recent years, and has also occupied the attention of the sugar planter since it has come to be generally appreciated as a source of considerable loss. It is probable that the loss to the industry through this source was suspected long before scientific investigation had established it as an actual fact, and probably before the nature of the causes of this change in sugars had been apprehended. For a long time the popular idea regarding the deterioration of sugars was that this action was due to certain changes which might be termed autogenous—that is, those changes independent of outside influences. As an example of this theory, we might take the idea that the slow deterioration of sugars is caused by the hydrolytic action of the organic acids which they contain. Later, however, this view was modified and the theory of the indirect inversion of sugar by bacteria became a popular one. By this indirect inversion is meant that which is due to the action of the acids developed by the micro-organisms occurring in sugars. One of the principal factors that have operated against an earlier solution of the problem is the difficulty of determining whether an apparent case of deterioration, as indicated by a fall in the polarization of a sugar, is due to any real decomposition of the product, or is only the result of a lack of uniformity of sampling. This has applied particularly to sugars that have been stored for considerable periods of time, and where the variation in the moisture content has not been accurately recorded.

Under these conditions it has been natural to attribute any change in the polarization of sugars to a change in their moisture content, while in the light of our present knowledge we have reasons to believe that many such changes are due to real deterioration in such products. Another factor that has very likely delayed the solution of this problem, and led us to least suspect the true cause of the deterioration of sugars, is that this material has hitherto been regarded as a highly unfavourable nutrient medium for micro-organisms in general. Both on account of its lack of the nutrient elements essential to the development of micro-organisms, and its comparatively low moisture content, we have hitherto classed sugars among those substances that are not at all subject to such action. In addition, moreover, to these conditions, which ordinarily lead us to regard it as free from the action of micro-organisms, its physical condition would seem to preclude their development owing to the high concentrations of the

solution surrounding the sugar crystals. In view of the many conditions lacking in sugar to fulfil the requirements of the great majority of bacterial species, the discovery of certain species which have adapted themselves to these unusual conditions for bacterial development is of interest, even considered apart from the economic importance of the changes that they induce. For, with the knowledge of this adaptation of bacteria to environments highly unfavourable to their development, as viewed from the standpoint of what we have hitherto regarded as essential to it, we are compelled to believe that the range of bacterial activities is far wider than we have thought them. If those species of bacteria which have been found to be the causative agents in the deterioration of sugars have become so well adapted to the environments of a relatively non-nitrogenous material as to have their nutrient demands sufficiently well satisfied in a 97 per cent. sugar as to enable them to propagate and carry on their metabolic activities, it would seem that many of our known species might as readily become adapted to less favourable nutrient media than what we have hitherto supposed was essential for their development. And this supposition is the more strikingly suggested in this particular case because the organisms constituting the bacterial flora of sugars are species well known to bacteriologists, but which prior to the discovery of their new environment were not accredited with any distinctive properties regarding their nutrition requirements. For their cultivation upon artificial culture media we have hitherto thought it necessary to provide them with nutrient elements in much the same proportions as are used for general work, and would not have thought that less elaborate substrata would suffice for their development.

In reviewing the literature upon the subject of this work we find that one of the earliest investigations was conducted at this station in 1902. This work,* "Relation of Bacteria to the Inversion of Crystallized Sugars," though purporting to be only a preliminary investigation upon the subject, was among the first that conclusively showed the causative relationship between bacteria and the deterioration of sugars. At a much earlier period Shorey † had attributed the deterioration of sugar to the action of *Penicillium glaucum*, the mycelium of which he claimed to have found in raw sugars. This work appeared in 1898. About the same time, or somewhat later, there appeared in this *Journal* the results of an investigation by R. Greig Smith ‡ upon "The Deterioration of Raw and Refined Sugar Crystals in Bulk." This article was a reprint from the proceedings of the Linnean Society of New South Wales, in

* Relation of Bacteria to the Inversion of Crystallized Sugars. W. R. Dodson. Bulletin 75, Louisiana Experiment Station.

† The Deterioration of Sugar by *Penicillium glaucum*. Jl. Soc. Chem. Ind., Jan., 1898.

‡ The Deterioration of Raw and Refined Sugar Crystals in Bulk. R. Greig Smith, reprint from Proc. Linnean Soc. of New South Wales.

which the deterioration of sugars was attributed to an organism to which he gave the name *Bac. levaniformans* on account of its power to form levan from sugars. In 1908 there appeared a report * of an investigation upon "The Deterioration of Sugars on Storage," by Noël Deerr and R. S. Norris at the Hawaiian Sugar Planters' Station. This report dealt largely with the results of investigations upon the deterioration of sugars in storage with particular reference to the relation between the rate of deterioration and the composition of the sugar. In a subsequent investigation, † conducted at the same institution by L. Lewton Brain and Noël Deerr, the results of which were embodied in the report entitled "The Bacterial Flora of Hawaiian Sugars," a more intensive study was made of the micro-organisms constituting the flora of sugars and the conditions influencing their action. The above publication appeared in 1908 shortly after the investigation covered by this publication had been instituted at this station. Having briefly indicated the several investigations that led up to the present work, it might be well to comment upon the extent to which conclusive data upon the subject had been adduced at the time of the inception of our investigation.

The causes of deterioration of sugars had been conclusively shown to be due to the action of bacteria, although the identification of these species had not been thoroughly worked out. Some of the conditions influencing the bacterial deterioration of sugars had also been studied to the distinct advantage of pointing out certain factors that tended to make certain sugars more susceptible to this action. With the knowledge of the advances that had been made in the subject, the present investigation was planned with the purpose of making a thoroughly comprehensive study of the problem, and contemplating an equally intensive study of the underlying causes of the phenomenon in all of its phases. It is only such knowledge as that deduced from investigations which seek adequate explanation of the many factors influencing a phenomenon, with the proper co-ordination by which they are assigned their true value, that the success of the practical application of this knowledge is assured. Realizing this fact, the author has sought in these investigations to explain the phenomenon of the bacterial deterioration of sugar in all of its phases by detecting all of those influences offered by the many conditions represented in the various products subject to this action. As is so frequently the case in any investigation, many important points of research have been suggested by the results of the experiments, but these were not considered essentially pertinent to the phase of the investigation that it was desired to lay stress on. These have therefore been reserved for future investigations which will naturally follow

* The Deterioration of Sugars on Storage. Noël Deerr and R. S. Norris, Bulletin Hawaiian Sugar Planters' Station.

† The Bacterial Flora of Hawaiian Sugars. L. Lewton Brain and Noël Deerr Bulletin Hawaiian Sugar Planters' Station.

from the inevitable demands for this extended knowledge upon the subject after the fundamental principles of the subject have attained general recognition.

Chapter I.

The Bacterial Flora of Sugars.

In order to properly ascertain the relation of bacteria to the deterioration of sugars it is necessary to determine the species that cause this action, and to thoroughly study their morphological and physiological characteristics for the purpose of identifying them as known species or of learning of their distinctive biological activities. We need to know the potential of each species in its relation to the deterioration of sugar before we can understand the significance of its presence in such products in regard to the changes that it is likely to bring about. It is obviously of first importance that we direct our attention to the investigation of the bacterial flora of sugars for the purpose of ascertaining the species that induce the deterioration of these products, for only by this knowledge can we intelligently anticipate the factors that must be considered in the general investigation. If there are a large number of species associated with this phenomenon, and sugars from different sources and of different compositions vary widely in their bacterial content, the problem will in that case be the more complicated, since the relation between each species and its favourite product must be established. If, on the other hand, only a few species are found to constitute the bacterial flora of sugars, and these species occur in all such products that are capable of supporting bacterial life, the problem is greatly simplified, since it is only necessary in that case to ascertain the potential of each species to induce the deterioration in question. In the premises of the case it seems conceivable that only comparatively few species would be found that have become adapted to this unusual habitat, so in this respect this part of the investigation has not required a very large amount of time or attention. It was greatly to be desired, however, that we should plan our studies of this subject in a manner that would insure adequate data upon the species associated with the phenomenon in order that our experimental results might be applicable to general conditions in the industry. If the species which we isolated for study had not been representative of the bacterial flora of sugars the results from our experiments in testing their action upon such products might not have sufficed as an explanation of the various degrees of deterioration that different sugars undergo. With the view of making a thorough study of this subject a large number of samples of sugars were procured for the work. This collection of samples embraced sugars from all parts of the world, representing various methods of manufacture and all the influences of varied climatic conditions. It was thought that a

thorough study both of the species occurring in these sugars, and of the rate of deterioration, would afford the desired data upon the subject, enabling us to arrive at definite conclusions regarding the number of species constituting the bacterial flora of such products and the factors that influenced their action. The sugars were placed in desirable containers, which were ordinary fruit jars that were provided with very closely fitting covers, and their chemical analyses and bacterial content were recorded in a note-book kept for that purpose. With these records of the analyses of each of the sugars, which were made monthly, the deterioration of any of the samples would suggest special investigation of its bacterial content. In conjunction with these studies, however, others were undertaken consisting of inoculating sterile sugar solutions with small portions of the samples, and in this way determining whether the species occurring in the different sugars were capable of inducing the decomposition of sugar in solution. After this work had progressed for a comparatively short time, and all of the samples in the collection had been somewhat thoroughly studied in this manner, it was noticed that all of the sugars that were found by analysis to be deteriorating would, when introduced in the solutions used for this purpose, induce a similar deterioration, thus establishing the reliability of the method. The species isolated from the sugars were propagated upon sucrose agar, and their properties studied with minuteness, both as regards their cultural and physiological characteristics. The following methods were employed in the isolation of the species from sugars: small portions of the samples were taken up by a sterile platinum loop and transferred either direct to liquid agar in tubes, from which they were poured into Petri dishes, or to tubes containing Greig Smith's sucrose solution, where they were allowed to develop before plating out. Where the number of the organisms per grm. in the samples was to be ascertained, the gravimetric method was employed, by which 0·5 grm. portions were weighed out in sterile plates, and then transferred to tubes containing 25 c.c. of sterile water, from which 0·5 c.c. portions were usually transferred to agar tubes, making a dilution of 1 to 100. The degree of dilution practiced, however, was varied for the different grades of sugars, as it was found to be too low in certain cases for low grade sugars, and too high for the higher grades, but after a little plating work had been done, the bacterial content of a sugar could be anticipated in most cases, and the dilution so regulated as to render the counting of colonies an easy matter. In the first stages of this work the widely dissimilar colony development upon the plates inoculated from the sugar samples indicated an almost bewildering number of species, while the morphological characteristics of the organisms from these colonies appeared as surprisingly similar. With the exception of certain cases, where involute forms occurred, the prevalent organisms were bacilli of

varying dimensions, but with the same staining properties and general morphological characteristics. The species observed were almost exclusively spore formers, and all were stained by Gram's stain. Where the sugars were transferred direct to the agar tubes, the presence of involute or degenerate forms in the colonies that developed upon the plates seemed of some significance. These forms are very often to be observed on old cultures, and usually indicate either an exhaustion of the nutrient elements of the medium, or the accumulation of metabolic products which render the medium unfavourable for the continuation of normal cell development. The occurrence of these forms in cultures from 18 to 24 hours old is therefore not to be explained by either of the above factors, as we would hardly suspect either so rapid an exhaustion of the food supply by the organisms composing the colonies on the plate, or an accumulation of products from the metabolism of the organisms that would so promptly exercise so marked a restrictive action. In order to prove this point inoculations were made from cultures that had been grown for some time on agar, to the plates where these involute forms were observed, from which it was found that the colonies developing from such inoculations did not show degenerate forms earlier than 48 hours. The explanation of the early development of these degenerate forms, where the agar tubes were inoculated direct from sugars, is in all probability that the difference in the density of the film of moisture surrounding the sugar crystals and the medium to which the sugar was transferred tends to produce a swelling of the cell protoplasm when the organisms are transferred to a medium of so much lower density. Through adaptation, the species of bacteria occurring in sugars have accustomed themselves to the density of the moisture film, and when suddenly transferred to the culture medium of much lower density develop abnormally as indicated in the forms produced. This phenomenon has been observed with many of the lower organisms,* which have been found to produce unusual forms when grown in solutions of various densities.

In order that none of the species constituting the bacterial flora of sugars and associated with the deterioration of such products might be overlooked, transfers were made from all of the colonies developing upon the plates appearing in the least distinctive in any particular. The cultural characteristics were made the basis for the isolation of the species, and although it was subsequently discovered in the course of the work of identification that many of the cultures thus isolated were really duplicates, yet this was easily corrected, and obviated the possibility of overlooking any of the species occurring in any of the products. After having completed the preliminary work of isolation from the sugar samples on hand there were

* Davenport's Action of the Density of the Medium on Protoplasm. Experimental Morphology, Chapter III.

some fifteen or twenty cultures collected, which were to be further studied as to their complete identification. The slight differences in the cultural characteristics of these cultures, which even from the first rendered a differentiation into species somewhat arbitrary, were after a few transfers completely obliterated, and as the more important physiological characteristics were identical from the beginning it was found that many of the cultures were duplicates. As the study of the species constituting the bacterial flora of sugars proceeded it was observed that three types of bacteria predominated, and all of the species were to be classed in one of these types. There were, of course, some species that differed in certain slight particulars from these, but the variation was hardly sufficient to suspect them of being new species, and they were regarded as races of one or the other of the three types. Greig Smith,* in his study of the bacterial flora of sugars, pointed out the affinities of these organisms, to which he gave the name *Bacillus levaniformans,* with the potato group of bacteria.

The members of this group are *Bacillus vulgatus, mesentericus fuscus, liodermos* and *mesentericus ruber,* and are very widely distributed in nature, occurring in soil, and, on account of their frequently contaminating potato cultures, by reason of the great resistance of their spores to heat, are known as "the potato group." These organisms are further characterized by their ability to form a kind of gum on potato, and in certain cases *Bac. vulgatus* has been known to induce a slimy fermentation of bread. The spores of this oragnism doubtless resist the baking temperature, and subsequently germinate and give rise to the fermentation in question.† This ability to form gum indicates a relationship between the *Bacillus levaniformans* of Greig Smith which induces the gum fermentation in sugar products and the above group of organisms, and Smith himself claims that the *Bacillus levaniformans* is related to the group as a whole, but sufficiently distinctive in its properties to be regarded as a different species. The relation between the organisms isolated from sugars and the members of the potato group is very strikingly indicated in the morphological characteristics, and as the latter are very widely distributed in nature, occurring in soil and upon vegetable matter, it was thought that the organisms found in sugars were really the same species and belonged to the same group. The difference in environment might easily account for the slight differences in the cultural and physiological characteristics, for it might be supposed that the conditions offered by sugars for bacterial development are such as would induce certain changes in the organism. As one of the distinctive properties of the organism is its ability to form gum levan from sugars, it was decided to test for the possession of this property by those of the potato group

* Vol. XXVI. Linnean Society of New South Wales.

† Fischer's Vorlesungen Ueber Bakteriocy, p. 62.

representing the prevalent types found in sugar products. The two types of most general occurrence very strikingly simulate the *Bac. mesentericus vulgatus* and the *Bac. mesentericus fuscus*, sometimes called the mesentery bacilli, owing to the striking resemblance of their growths on potato to the mesenteries. These two species were therefore isolated from soil and kept for a comparative study, in order to determine their ability to form levan from sugar, and to see if the differences in cultural characteristics, as observed when first isolated from the two sources, would disappear after they had been grown for a time under identical influences. It was found that the species isolated from soil would, when inoculated into a sugar solution, induce the gum fermentation almost as vigorously as those which had been separated from sugars. Continued transfers also tended to equalize this property, as well as to cause a convergence of the cultural characteristics, which differed to some extent at the beginning, and, although some slight differences were always to be observed, this was not greater than is sometimes met with in variations of the same culture. It is but fair to assume therefore that the organisms that have been found to be associated with the deterioration of sugars are derived forms of the potato group of bacteria, which are noted for the very high resistance of their spores to heat. It is on account of this property that the species occurring in cane juices are enabled to withstand the temperature of the manufacturing process, and to persist throughout the successive stages, thus forming the contamination of the finished sugar. Lafar claims* that the spores of the potato bacilli can withstand the temperature of streaming steam for six or seven hours, thus making it the most resistant of bacterial species. The very high resistance of the species occurring in sugars still further suggests the relationship between the two groups.

The bacterial species constituting the bacterial flora of sugars may be grouped in three divisions according to their morphological and physiological characteristics, and these groups may be properly represented by the *Basillus vulgatus*, the *Buscillus mesentericus fuscus*, and a bacillus form much larger than either of these species, which is very probably the *Bacillus megatherium*. The *Bacillus mesentericus vulgatus* type is more prevalent in sugars than the other two, and, so far as has been observed is more active in bringing about the deterioration of sugar products.

In addition to the three above-mentioned types which occur most frequently, *Bacillus liodermos*, *Bacillus mesentericus niger*, and *Bacillus granulatus mesentericus*, all members of the potato group, are sometimes found. These species are doubtless derived forms of the more commonly found types, *Bacillus vulgatus* and *Bacillus mesentericus fuscus*. In one instance we have met with *Bacillus niger*, but it seems rarely to occur in sugar products.

* Technichc Mycologie.

Another species that is also very probably related to the potato group of organisms is the *Bacterium mesentericus panis viscosus*, or the organism of stringy bread. This is a Gram-positive organism and somewhat resembles the *Bacillus mesentericus fuscus* in its cultural characteristics. It has already been noted that the members of the potato group of bacteria are sometimes associated with the slimy fermentation of bread, so it would seem that this organism may be a race of one of the members of that group.

It seems probable that all of the gum-forming organisms above described are derived types of the potato group of organisms, and are in reality only races of those species. The different environmental influences may very well account for certain of the slight differences in the cultural characters.

The fact that the potato group of organisms and the species above described and those constituting the bacterial flora of sugar products have so many common characters, and since they are all characterized by their ability to form gum from sugar, it is more than likely that they are closely related species.

THE BACTERIAL FLORA OF SUGARS.

On determining the most important bio-chemical characteristics of these organisms, it was found that each of the species is Gram-positive in their staining action, and that they are spore formers and gelatine liquefiers. They vary to some extent in the relative rate of their action upon gelatine, some causing liquefaction very quickly, while others act very slowly. They may be divided into three groups upon the basis of their morphological and physiological characters. These three groups would be represented by the *mesentericus vulgatus* type, the *mesentericus fuscus* type, and the *megatherium* type.

The different types are to be regarded as races of the species for which they are named. As their most important characteristics are identical, it is most likely that the differences in cultural characteristics are due to the environmental influences to which they were subjected. It is very likely, for instance, that the influence of the environment of sugar crystals would have a tendency to make their characteristics different from what they would have been under the environmental conditions offered by a syrup or molasses. As the different species were isolated from many different sources representing greatly divergent environmental influences, it was very likely that their cultural characteristic was due to this difference. This classification was easily made upon the basis of these differences in their cultural characteristics, as the bio-chemical features were quite constant for the various species. The group as a whole are characterized by the high resistance of their spores to heat and their very low nutrient requirements in respect of their nitrogen supply, and in their marked ability to destroy sucrose. All the species

developed in albumen-free medium. The cultural characteristics of the different species vary so greatly at different times that it becomes very confusing and very difficult to determine where the various species end and the new species begin. Many attempts were made to discover such conditions under which we might expect to operate with the result of yielding constant characteristics. To this end various media were used, and these tried with various modifications for the purpose of obtaining absolutely uniform results. The ordinary plain agar was used as a medium, and in addition the 10 per cent. sucrose agar recommended by Greig Smith was also used. The titration of the medium was usually corrected to plus 0·50 per cent. Fuller's standard. The agar was of 1·5 per cent. strength. At times certain variations in the cultural characteristics of the species were found to be due to the variation in the titration of the medium, which was often changed during sterilization. It was found, for instance, that the cultural characteristics of the species in the plain agar titrating plus 0·50 per cent. Fuller's standard was quite different from that on a similar medium of plus 1 per cent. This group of organisms seemed peculiarly influenced by these changes in the titration of the medium in which they grew, this being attributed to the influence of this factor upon their gum-forming property. This view was strengthened by observation that in some old sucrose sugar cultures which we had in 300 c.c. Erlenmeyer flasks in the incubator as stock cultures, a liquefaction, or, more probably, a disintegration of the medium was observed. The agar was in the proportion of 1·5 per cent, and although it was not liquefied as the term ordinarily implies, yet it showed a marked disintegration and a tendency to lose its original consistency. This phenomenon was usually observed in sucrose agar where the titration was slightly less than plus 0·50 per cent. Fuller's standard, and as this action upon agar seemed to have been stimulated by the presence of sucrose in the medium, and as it seemed to be also favoured by neutral or slightly alkaline conditions, it was supposed that the gum-forming action of the organism had in some way influenced this solidifying property of the agar-agar. The phenomenon of the liquefying action of the agar has seldom been observed and there is little available literature on the subject. Dr. Havan Metcalf,* of the University of California, in his work on *Bacterium teutlium*, which he isolated from sugar beets, describes a similar action upon agar on the part of that organism.

Dr. Erwin F. Smith, of the Bureau of Plant Industry, United States Department of Agriculture, has also made mention of this phenomenon. When we first observed this liquefaction of agar we attributed it to the possible excessive secretion of diastase which might have had a similar action upon the carbohydrate agar-agar as

*Centr. Bakt.

upon starch. This idea was contradicted, however, by the observation that the liquefaction was always more active in sucrose agar than in ordinary plain agar. This was taken as an indication that the action upon agar was not due to diastase, for otherwise we should have expected the secretion of such an enzyme to have been stimulated in the medium where there was no sugar present. To prove the point further, the following experiments were conducted: A solution of the same composition as our standard sucrose solution was made containing 5 per cent. of starch instead of sugar. This was solidified with agar and inoculated with a culture of the organism. If the liquefaction of the agar was due to diastase we should have expected to have found a greater liquefaction of agar in the presence of starch, since in this case the lack of a fermentable sugar would have tended to evoke a greater secretion of diastase. The result, however, showed no such action to have taken place in the starch agar, although it had been previously found in our experiments with starch solutions that the organism secreted diastase. It is most likely, therefore, that the disintegration of agar is not due to the action of diastase, but that it is caused in the process of the gum fermentation of sucrose. In old cultures where the sucrose has all been converted into gum, it is very likely that the carbohydrate agar-agar is acted upon to a slight extent by the gum-forming enzyme secreted by the organism.

The Resistance of the Spores of the Bacteria to Heat.

As the initial contamination of sucrose by the deteriorative type of bacteria depends upon the resistance of the spores of these bacteria to high temperatures, it will be of interest to us to investigate this property under laboratory conditions. If we should find in such an investigation that the spores of these organisms can withstand higher temperatures than is reached in the manufacturing process of sugar, we should not expect the contamination of a sugar to depend upon exposures subsequent to the manufacture of such products. For the purpose of testing the resistance of the spores to high temperatures, tubes containing 25 c.c. of the standard sucrose solution were prepared and inoculated with cultures in which the spores of the species had been observed. The tubes were then subjected to various temperatures for various periods. It was found that the spores of the organisms were highly resistant and would easily withstand the temperature incident to the manufacture of sugar. It was further observed that the organisms survived the temperature of 212° F., which is ordinarily about the highest temperature reached in sugar manufacture, and that only a few of the spores were entirely destroyed, even after two hours exposure. Even at 230° F. all of the spores were not killed in fifteen minutes exposure. These results fully explain the fact that the deteriorative type of bacteria are always present in freshly made sugars, as will be seen from Part IV of this paper.

Resistance to Formaldehyde.

The use of formaldehyde as an antiseptic for the preservation of sugar products is almost universally practised in the sugar industry, where it becomes necessary to use such an agent. This antiseptic is more often used upon the occasion of a breakdown in mills where juice or syrup would be likely to deteriorate through fermentative action. In such cases it is customary to add small quantities of this antiseptic so that fermentation would be held in check while waiting for the work to be resumed. As the proportion in which this material is used varies in different localities, it was thought that it might be interesting to determine the proportion in which it would be effective as an antiseptic towards the organism causing the gum fermentation of sugars. As a result it was established that in the proportions of 1 to 5000 of 40 per cent. formaldehyde all the species were completely restrained. Spencer* recommends 6 c.c. of 40 per cent. formaldehyde per cubic foot of raw juice, which is approximately equivalent to 1 to 5000. In the proportion of 1 to 10,000 formaldehyde was efficient as an antiseptic in about 50 per cent. of the cases. It is likely that it would in proportions of 1 to 7500 be sufficient to restrain the development of these organisms. It was further noticed that even in the concentration of 1 to 100 formaldehyde were not germicidal upon all of the species investigated. As it is very rarely used as a germicide, the proportions in which it possesses this property are of less interest than are its antiseptic properties. It appears that formaldehyde to be absolutely efficient as an antiseptic for the gum-forming organisms should be used in the proportions of 1 to 5000

Development of Organisms at Elevated Temperatures.

In the investigation of the properties of the species constituting the bacterial flora of sugars, it was found that the optimum temperature for their development was 37·5° C., but it was found that they could adapt themselves to a very wide range of temperature conditions. As their natural environment would represent many variations in temperatures, it is natural to suppose that the group as a whole would not be very rigid in their requirements in respect to temperature. As certain cases of deterioration of sugar products during the course of manufacture suggested the power of the gum-forming organisms to cause an active deterioration of sugar products at very elevated temperatures, it was thought that an investigation of this property would prove of interest. The various temperatures were tried from 37·5 to 65° C. (100 to 150° F.) with the result that no development could be observed at temperatures higher than 130° F., and even at this temperature a large per cent. of the cases showed no development.

In concluding this part of our investigation we will state that the bacterial flora of sugars comprises the well-known potato group of

*Spencer's "Handbook for Cane Sugar Manufacturers."

bacilli. These species cause an active destruction of sucrose owing to their ability to transform it into gum levan. It is very likely that the gum-forming organisms described by other authors were in reality members of this group, which, owing to change of environment, show some cultural variations. The principal characteristics of this group of organisms are:

1. Their ability to form gum from sugars.
2. The high resistance of their spores to heat.
3. Their very low nutrient requirements.

And it will be noted that all of these characteristics correspond to those of the potato group of organisms.

(To be continued.)

SOME REMARKS ON THE SULPHUR STATION.*

By W. van der Haas,

Sewoe-Galoor, Java.

For the preparation of white sugar the use of sulphurous acid is becoming more and more extended, and it therefore seemed useful to draw attention to some points on the management of the oven.

Sulphurous acid (SO_2) is still obtained on the technical scale by burning sulphur, for which purpose the double refined Silician product is particularly to be recommended, on account of its low ash content. This burning operation takes place in iron ovens, in which the air necessary for oxidation is generally passed through the furnace by means of a compressor.

Although it has been known for a long time how very necessary it is to have the air dry, so as to avoid the formation of sulphuric acid (SO_3) with all its disastrous consequences, yet there are factories in which this is omitted. This drying of the air is most conveniently done by placing before the compressor a brick chamber containing perforated plates on which pieces of unslaked lime are spread.

As to the amount of lime necessary, this may be found from the quantity of sulphur added to the juices in the form of sulphurous acid every 24 hours.

To give a precise calculation, an installation has a double-acting compressor, with a diameter of 30 cm. (nearly 12 in.), a stroke of 30 cm. (nearly 12 in.), and makes 40 strokes per minute for the necessary pressure. It has an efficiency of 80 per cent., and therefore draws 1955 c.m. (69,042 c. ft.) of air through the drying chamber:

$$\frac{80}{100} \times 24 \times 60 \times 2 \times 40 \times \frac{22}{7} \times 15 \times 15 \times 30 = 1955.$$

---

* Abridged translation from the *Archief*.

Taking the temperature of the air at 35° C., and the maximum weight of water as 39·4 grms. per c.m., the maximum weight of water to be taken up by the lime will be:

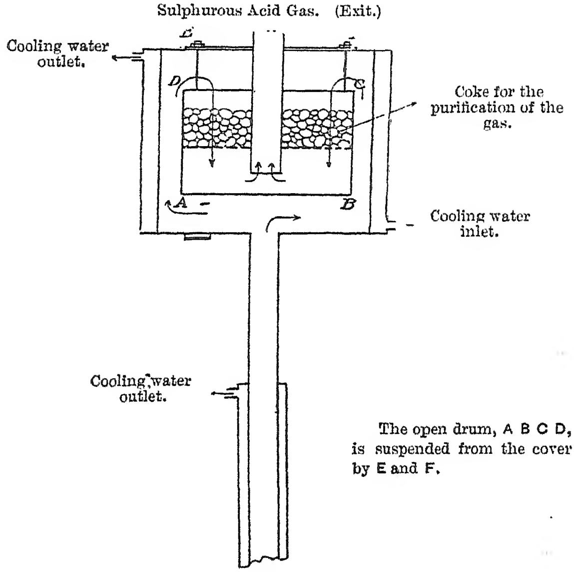
$$1955 \times 40 = 78{\cdot}2 \text{ kilos.}$$

Accepting that the absorption of the water takes place according to the equation: CaO (quicklime) $+ H_2O$ (water) $= Ca(OH)_2$ (slaked lime), in which CaO is 56, and H_2O is 18, then it is clear that the amount of lime necessary every 24 hours would be:

$$\frac{56}{18} \times 78{\cdot}2 \text{ kilos.} = 244 \text{ kilos.}$$

It is, however, advisable to take double the calculated quantity, since broken lime is surrounded by a layer of slaked lime, $Ca(OH_2)$, which considerably diminishes its efficiency.

Sulphurous Acid Gas. (Exit.)



Sulphurous Acid Gas. (Inlet.)

A case came under observation in which it was apparent that, notwithstanding the precautionary measure just mentioned, water had entered the oven in some way or other. The thin-juice, treated by sulphurous acid at the second carbonatation, was coloured black as it left the station, while the presence of sulphuretted hydrogen (H_2S) was easily recognised, and was also identified by its well-known reaction on filter-paper saturated with lead acetate.

On examination it was found that the coke in the gas purifier had taken fire. The formation of sulphuretted hydrogen in this way may

be explained by the action of the compressor in carrying burning pieces from the sulphur oven over to the gas-coke serving for the purification of the gas, and thus setting it on fire. Since most of the oxygen of the atmospheric air had been used for burning the sulphur, the coke was only able to burn at the expense of the sulphurous acid, which had thus become reduced, according to the following equation:

$$3C + 2H_2O + 2SO_2 = 3CO_2 + 2H_2S.$$

Another explanation might be offered, namely, that by the presence of water sulphuric acid had first been formed, and this acting on the impurities of the coke, especially the sulphides, had evolved sulphuretted hydrogen. Since, however, it was not found possible by acting on this coke with sulphuric acid to form sulphuretted hydrogen to the extent that had actually occurred, this hypothesis seemed less probable.

Further investigation showed that the coke used was not dry, and it was also ascertained that in charging the ovens wet sulphur from the cooling water had been added.

Although immediate measures were taken against this, it also occurred to us to also take the precaution of substituting for the coke in the gas-purifier pumice stone, which is certainly much dearer, but can be regenerated after being in use for some time.

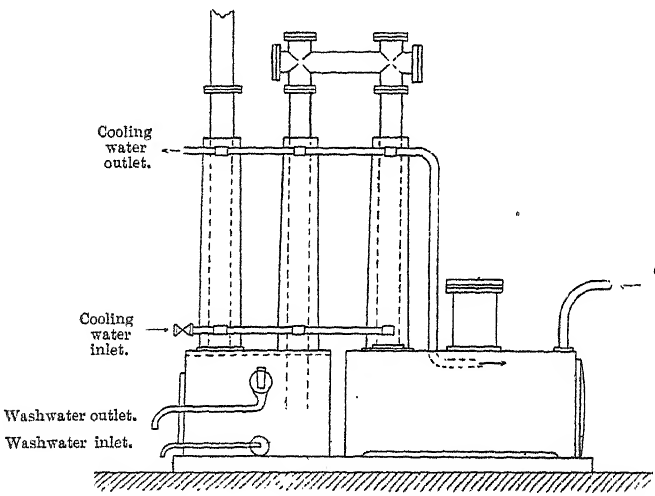
A second question, to which very little attention is paid, is the cooling. Owing to the heat liberated by the oxidation, a certain amount of sulphur in the form of vapour is carried over, which on cooling becomes re-crystallized. This phenomenon, called "sublimation," always occurs to a more or less extent. So as to prevent the sublimed sulphur cooling in the outlet pipes, and choking them up, an apparatus called a "sublimator," is placed after the oven, in which by artificial cooling, and a suitable setting of the pipes, the sublimed sulphur is cooled, and the irregularity indicated obviated. An apparatus, which has given full satisfaction in practice is represented in the first of the two sketches.

Recently installations have been supplied in which the gas-purifier serves at the same time as sublimator. By further widening the outlet pipe of the sulphur oven as is shown in the second sketch, the rapidity of the gas is proportionally diminished, and sublimation favoured. Nevertheless, the outlet pipe of the sulphur oven should be cooled as much as possible, since the cooler the gas is on entering the sublimer the more rapid will be the crystallization of the sulphur, and the better the appliance will answer its purpose.

Artificial cooling of the oven itself may have the effect of hindering heavy sublimation. By keeping the cooling water at 90° C. this can be accomplished without the cooling affecting the process of burning. For this same object, it is desirable to lead the air into the oven in such a way that there is opportunity for it to become heated before reaching the burning sulphur, as, *e.g.*, by passing it through a bent pipe placed against the top of the oven. In this way any undesirable cooling of the burning mass can be prevented.

It will also be recognised that if the air is driven too fast through the oven, any preliminary heating thus becomes out of the question. Then the burning sulphur becomes cooled too much, and the chance of it being rapidly and completely combined with the atmospheric air is small, so that the percentage of sulphurous acid in the gaseous mixture is greatly diminished, stoppage of the operation even thus being caused. Hence it is especially desirable to establish the correct relationship between the size of oven and compressor.

Further, for an economical use of the sulphur, the area in which combustion occurs should not be too great. As the standard for carbonatation factories of a mill capacity of 10,000 piculs (593 tons), 0·5 of a c.m. (17·6 c. ft.) may be given.



In conclusion, some figures relating to the use of sulphur in carbonatation factories in Java during the 1910 campaign may be quoted:—(1) Factory sulphuring thin-juice, thick-juice, and covering syrup; capacity of mill, 9000 piculs (534 tons); combustion area, 1 sq. m. (10·7 sq. ft.); sulphur used per 1000 piculs (59·3 tons) of cane, 12·9 kilos. (284 lbs.). (2) Factory sulphuring thick-juices and syrups; mill capacity, 10,000 piculs (593 tons); combustion area, 0·5 sq. m. (5·35 sq. ft.); sulphur used per 10,000 piculs of cane (593 tons), 9·13 kilos. (20·0 lbs.). (3) Factory sulphuring thin-juice, thick-juice, and syrups (according to the Harloff "acid thin-juice" process); mill capacity, 11,000 piculs (653 tons); combustion area, 1 sq. m. (10·7 sq. ft.); sulphur used per 1000 piculs (59·3 tons) of cane, 15·0 kilos. (33·0 lbs.).

THE DETERMINATION OF REDUCING SUGAR IN CANE SUGAR FACTORY PRODUCTS.

By H. Pellet.

So as to follow the working of a cane sugar factory, and also to take account of the quality of the canes, it is necessary to determine the reducing sugar in the juices and syrups, not once or twice every 12 hours as is often done, but at least four times. In the juices should be included all juices coming from the samples of cane received, as well as the juices of manufacture.

We have stated that the best process to use is the one well known in France under the name of "Violette's method." So far back as 1867, Violette studied the process in question in all its details and completely worked it out.

It is possible to make a large number of determinations by means of this method, which is sufficiently exact for this kind of investigation. With a little practice it may be used at night equally well as during the day.

Sometimes it is necessary to analyse a series of 10, 15, or 25 samples of juice, as, for example, those from experimental fields when studying varieties of cane, modes of plantation, or the influence of different manures, &c. In such cases it is necessary, so as to have average results sufficiently exact to draw unquestionable conclusions, to have a large number of samples, bearing in mind the differences of composition which exist in different batches of material. With analyses like these it is necessary to operate very rapidly.

The ordinary operation may be resolved as follows: (1) Heating the copper solution contained in a tube; (2) adding the sugar solution being analysed in small amounts; and (3) emptying the burette, and filling it with fresh liquid. If the time required for each of these manipulations be noted, it will be found that each of the three demands about the same.

We have, therefore, thought it would be of interest to indicate a few very simple directions for rapid working: (1) Prepare the number of tubes requisite, corresponding to the number of determinations to be made, and introduce into them the proper volume of copper solution by means of a burette with an automatic filling arrangement. (2) Place all these tubes in a water-bath, which is almost boiling. (3) Using two burettes filled with the sugar solutions to be titrated, take one of the heated tubes containing the copper solution, and wipe it; then run the sugar solution into it, and continue the addition little by little until the exact decolorization of the blue liquid occurs, as has been explained in another note. With some practice, little time is required, the volume of sugar solution to be added being approximately known.

For adding the sugar solution either an ordinary or a hand burette may be used. With the Mohr (or Mohr-Pellet) burette, the tube is held with a wooden clip in the left hand, while the metallic pinch-cock or the tap of the burette is manipulated with the other, expertness soon being acquired.

While carrying out a titration, an assistant fills the second burette with the sugar solution of a second sample. The operator, having finished one titration, has only to take the re-filled burette, and in this way he passes from one burette to another without losing time.

Further, as the time which would be occupied in heating the copper solution directly is considerably reduced by using a water-bath in the manner indicated above, it is possible to work very quickly. Indeed, by adhering strictly to the procedure given above, we have been able to effect 40 determinations in the hour.

THE PURIFICATION OF CANE JUICE BY MEANS OF BURNT FILTER PRESS SCUM.*

(Preliminary Note)

By J. J. Hazewinkel,
Director of the West Java Sugar Experiment Station.

For some time past the author has had the conviction that filter scum, burnt in a suitable manner, should possess properties more or less corresponding to animal charcoal.

On putting this idea to the test, the results obtained were important, and are given below.

One hundred grms. of dried filter scum gave 46 grms. of carbonaceous residue. This was treated 12 times in succession with 100 c.c. lots of a dark syrup of 31·5° Brix.

The effect was striking. Even the twelfth fraction had undergone decolorization, although slightly. Taking the intensity of colour of the untreated syrup as 100, then that of the different fractions was:

No. 1	25·0	No. 7	62·5
,, 2	35·0	,, 8	66·0
,, 3	45·0	,, 9	70·0
,, 4	48·0	,, 10	73·5
,, 5	52·5	,, 11	77·0
,, 6	57·5	,, 12	80·0

The average colour value of all the filtrates together was 62·5, so that more than one-third of the colour had disappeared. The colour of the first fractions did not indicate that a very considerable decolorization would have been obtained if the mixed filtrates had once again been passed over the 46 grms. of residue.

The figures for the colour clearly show that the work could be carried out in batteries either of two or at most of three filters.

* Translated from the *Archief*.

Taking the specific gravity of the porous substance as 1, then each body of the battery should be $\frac{1}{24}$th of the volume of the juice passing through. Supposing a filter runs six hours, then with a thick-juice production of 288,000 litres per day, each body of a battery should have a capacity of 3 c.m., and as another six hours must be allowed for recharging, two batteries are thus necessary, each of 2×3 c.m. contents. Most conveniently, six batteries, each having two filters of 1 c.m., might be used, so as to effect systematic "sweetening-off" (commencing with the thick-juice), and to make working more easy.

This calculation, however, becomes incorrect if the rapidity of the filtration over the mass is less than assumed, or if the reaction requires time. No investigations have so far been carried out in this direction, and it is quite possible that the conditions of filtration, or of reaction, may render the application in one way or other impossible.

With the burnt scum, as obtained by direct, rational charring, filtration is extremely slow, and can only be properly effected under reduced pressure. Hence it would be necessary to bring the burnt material into such a form that filtration can be suitably carried out. Then, from the nature of things, the contact between liquid and scum would be less complete, and moreover it is very possible that the time of reaction would then be too long.

It may be added that the juice must be filtered hot, and that the burnt filter scum should previously be washed.

The study of the problem on the technical scale has been commenced.

The larger and most important sugar estates of Santo Domingo are located on the southern coast principally near San Pedro de Macoris (which has seven of them) and Azua. There are also some sugar estates in the immediate neighbourhood of Santo Domingo city. The sugar produced is all centrifugal. Practically all last year's crop came to the United Kingdom, viâ the States.

In reply to a question in the House of Commons, the Secretary to the Board of Agriculture stated that the following Agricultural Colleges were going to carry out experiments this season in the growing of sugar beet. Five acres will be grown at each of the following institutions:—South-Eastern Agricultural College, Wye; Royal Agricultural College, Cirencester; Harper Adams Agricultural College, Newport, Salop; Midland Agricultural and Dairy College, Kingston, Derby; and the County Technical Laboratories, Chelmsford. Three acres will be grown at the Agricultural Institute, Ridgmount, and two acres at the Seale Hayne Agricultural College, Newton Abbott.

THE NON-INFLUENCE OF THE NON-SUGAR ORGANIC SUBSTANCES OF THE CANE ON IODINE IN PRESENCE OF SULPHUROUS ACID.

By P. DE SORNAY,

Assistant Director of the Station Agronomique, Mauritius.

At the General Meeting of the Association des Chimistes of 13th April, 1910, M. Saillard, speaking on the subject of the determination of sulphurous acid, said: "As to the juice of the *sucrerie*, in it the sulphurous acid may be determined approximately with standard iodine and the use of starch. In this way a rigorously exact result is not obtained, because there are present organic substances, which act on the iodine. And even if an iodine determination be made before the sulphitation, and this last result deducted from the first, it is not any more certain that the estimation is exact, since it may happen that during the sulphitation the reaction of the organic substances, in respect of the iodine, undergoes modification."

Previously we have observed in a research published in the *Bulletin* (see also this *Jl.*, 1910, 144), that a definite quantity of sulphurous acid added to a juice was entirely recovered by the volumetric method of determining sulphurous acid by iodine, without preliminary distillation.

Tho observation of M. Saillard, which may be correct for beetroot working, does not appear to give the same results with sulphited green juices of the cane factory. Indeed, in the beetroot *sucrerie* a slight absorption of iodine may be observed with non-sulphited, second carbonatation juice, for this juice may contain both sulphites and sulphides. Carbonic acid gas itself may even contain a little sulphurous acid, owing to the sulphur in the coke, and at times also sulphuretted hydrogen, if the combustion had been incomplete. The lime may contain sulphides, resulting from the action of the coal upon the sulphates. For all these reasons, it may be inferred that the iodine absorbed, other than that corresponding to sulphitation, is not due to organic substances.

It has occurred to us to investigate the manner in which these organic substances may act on the iodine in presence of sulphurous acid.

According to the results obtained, this action would appear to be nothing, since a quantity of juice, absorbing 0·5 to 1·0 c.c. of iodine solution, does not influence the titration by iodine of the sulphurous acid used for the decolorization of this same juice.

Four series of experiments which we have made in this direction are herewith given, care having been taken to reduce each to the same conditions of dilution. The solution of sulphurous acid was comparatively weak, for if too concentrated a solution be used there is

a loss whilst manipulating. This may be detected by the titration of sulphurous acid, which will vary within limits, the average of which is not even permissible:—

FIRST SERIES.

	Iodine Solution. 1	2	3
50 c.c. H_2O + 25 c.c. Juice	0·9	1·1	1·0
50 c.c. SO_2 + 25 c.c. H_2O	5·0	5·0	5·0
50 c.c. SO_2 + 25 c.c. Juice	5·0	5·0	5·0

SECOND SERIES.

	1	2	
50 c.c. H_2O + 25 c.c. Juice	0·7	1·0	0·9
50 c.c. SO_2 + 25 c.c. H_2O	8·5	8·5	8·5
50 c.c. SO_2 + 25 c.c. Juice	8·5	8·5	8·5

THIRD SERIES.

		1	2	
100 c.c. H_2O+25 c.c. SO_2;	50 c.c. mixture+50 c.c. H_2O	7·3	7·29	7·2
100 c.c Juice+25 c.c. H_2O;	,, ,, ,,	1·8	2·0	1·7
100 c.c. Juice+25 c.c. SO_2;	,, ,, ,,	7·3	7·3	7·2

FOURTH SERIES.

		1	2	3
100 c.c. H_2O+25 c.c. SO_2;	50 c.c. mixture+50 c.c. H_2O	7·0	7·0	7·0
100 c.c. Juice+25 c.c. H_2O;	,, ,, ,,	2·0	2·2	1·9
100 c.c. Juice+25 c.c. SO_2;	,, ,, ,,	7·1	7·0	7·0

However weak the solution of sulphurous acid may be, it is of consequence for exact titration to run it into the juice or water in such a way that admixture is immediately effected, since otherwise variations occur.

The absorption of iodine by the organic substances of the non-sulphited juice takes place very rapidly at first, but to arrive at a permanent coloration it is necessary to add one or two drops several times at suitable intervals.

It is not sufficient to add to the juice a few drops of iodine, and take the immediate blue colour as the end-point, for the organic matter absorbs the iodine gradually, in the same way as it acts slowly in the cold upon permanganate. But when a coloration lasting five or six minutes is obtained, it is unnecessary to say that the titration may be taken as finished, provided that in the time no fresh absorption occurs.

Sucrose has no action on iodine. Experiments made with pure sucrose solutions justify the statement that from 0·1 to 0·2 c.c. suffices for the formation of the iodide of starch, and to keep the blue tint permanent for a number of hours:

Sucrose solutions,	5	per cent.;	50 c.c.	= 0·05 c.c.	iodine solution.
,,	10	,,	,,	= 0·05 c.c.	,,
,,	15	,,	,,	= 0·01 c.c.	,,
,,	20	,,	,,	= 0·01 c.c.	,,

Neither has reducing sugar (glucose) any action on iodine. It would therefore appear to be only the organic non-sugar substances

which could act on the iodine, the quantity of which absorbed would vary according to proportions.

The determinations we have made would appear to indicate that such is the case:

		Density.		Non-sugar.		Iodine absorbed.
1	100 c.c. juice + starch + 300 c.c. H_2O.	1074	..	1·36	..	4·0 c.c.
2	,, ,, ,, ,, ..	1080	..	1·06	..	3·6 c.c.
3	,, ,, ,, ,, ..	1085	..	1·41	..	4·4 c.c.
4	,, ,, ,, ,, ..	1078	..	0·75	..	2·8 c.c.
5	,, ,, ,, ,, ..	1080	..	1·36	..	3·8 c.c.
6	,, ,, ,, ,, ..	1082	..	1·00	..	3·4 c.c.

With the sulphited juice the blue tint obtained is permanent, or at the end of 30 minutes it may lighten. There is no need to take account of the feeble influence which might be exerted by organic matter after so long a time, because it is probable that this lightening may be due rather to the slow settling-out of the iodide of starch.

From all these experiments, it follows that the organic substances do not appear to have had any action on the iodine in presence of sulphurous acid, for otherwise we should have detected the iodine necessary for the oxidation of the sulphurous acid and that absorbed by the organic matter.

We are not able to give an explanation of these facts, which are none the less real; we are contented to state them.

Mr. Zerban, in March, 1908, published a memoir entitled "Investigations on the use of Sulphur and its Combinations in the Sugar House"* and on page 31 we see that after having titrated an aqueous solution of sulphurous acid, 20 c.c. of which corresponded to 13·6 c.c. of iodine, juices were treated by this aqueous solution of sulphurous acid, and the quantity added entirely recovered:—

Juice.		Sulphurous Water.		Iodine Solution.
50 c.c.	..	10 c.c.	..	6·8 c.c.
50 c.c.	..	20 c.c.	..	13·65 c.c.
50 c.c.	..	20 c.c.	..	13·75 c.c.
100 c.c.	..	20 c.c.	..	13·6 c.c.
100 c.c.	..	20 c.c.	..	13·6 c.c.
50 c.c.	..	40 c.c.	..	27·2 c.c.

Mr. Zerban concluded that the decolorizing effect of the sulphurous acid on the juice is evidently due to the formation of new compounds by addition and not by reduction, since in this latter case a portion of the sulphurous acid would be converted into sulphuric acid.

The opinion of Mr. Zerban on the influence of sulphurous acid on the colouring matter of the cane is shared by numerous experts, such as Pellet, Vivien, &c., whilst others consider that it only acts as a reducing agent. M. Horsin-Déon maintains that the action of sulphurous acid is not to decompose the colouring matter; that a combination probably forms, with the colouring matter acting as a weak base readily displaceable by a strong alkali.

* For which publication we are indebted to the kindness of our colleague, Baissac.

Whatever may be the view taken on this question, it is nevertheless true that in Mr. Zerban's experiments, and in those of others, it is established that the organic matter has no action on the iodine. However, we are not in accord with Mr. Zerban when he says that 100 c.c. of raw juice absorb only 2·2 c.c. of standard iodine solution. If we hold to our mode of operating we see first that this absorption is much higher, and further that it varies according to the content of the juice in non-sugar.

The influence of the organic matter on the iodine seems therefore ot be neutralized by the sulphurous acid, and the results obtained are sufficiently conclusive to neglect distilling the sulphited juice for the determination of the suphurous acid.

Moreover, in Mr. Zerban's memoir we further notice some comparative experiments on the determination of sulphurous acid, volumetrically and by distillation. The differences are insignificant, and can be considered as permissible in the limits of error.

50 c.c. of Sulphited Juice.

Distillation.		Titration.		Difference.
0·0185	..	0·0211	..	0·0026
0·0269	..	0·0286	..	0·0017
0·0223	..	0·0294	..	0·0031
0·0204	..	0·0214	..	0·0010
0·0242	..	0·0249	..	0·0007

50 c.c. of Clarified Juice.

Distillation.		Titration.		Difference.
0·0133	..	0·0153	..	0·0020
0·0166	..	0·0176	..	0·0010
0·0224	..	0·0240	..	0·0016
0·0173	..	0·0184	..	0·0011
0·0291	..	0·0306	..	0·0013

The average difference between the two methods is 0·0015 for 50 c.c., or 0·003 for 100 c.c. This shows clearly that the volumetric estimation is similarly practically exact.

Not only the time occupied in the estimation of sulphurous acid by distillation should be taken into account, but the difficulties that may arise according to the *modus operandi* adopted should also be considered.

At the Second Congrèss of the Croix Blanche de Genève, held at Paris in 1909, M. P. Cazenave, Oenologist at Mendoza, Argentine, set forth the various comparative experiments he had made on the estimation of sulphurous acid by distillation (de Haas' method).

Whether a current of carbonic acid be used, or an atmosphere of carbonic acid gas be formed in the flask, or if no precaution at all be taken to eliminate the air, no sensible difference between the three modes of procedure can be found on completing the estimation with all necessary precautions by weighing as barium sulphate.

The author concluded that for the estimation as barium sulphate with distillation into an excess of iodine it is not necessary to operate by means of carbonic acid gas.

This method of estimation being long, M. Cazenave endeavoured to obvitate the precipitation of barium sulphate, and to replace it by the volumetric estimation, receiving the product of the distillation either in a known excess of iodine, the remaining excess being estimated subsequently by sodium hyposulphite, or else in a 5 per cent. solution of sodium or of ammonium hydroxide.

The first procedure, although very simple, gives absolutely false results by reason of the entrainment of iodine by the carbonic acid being evolved. The losses of iodine may reach 74 per cent., and even without a current of carbonic acid gas there is a loss of iodine. Several experiments made by us confirm these results.

With potassium hydroxide, distillation must be conducted very slowly, or the product of the distillation received in a tube filled with beads, otherwise a portion of the sulphurous acid vapour is entrained by the bubbles of gas, which are splashed up, causing a loss.

In a solution of ammonium hydroxide, when distilling without a current of carbonic acid, there is oxidation of sulphurous acid to the extent of 8 per cent. With a current of carbonic acid, the losses are much higher, by reason of the great difficulty of absorption by the alkaline liquor.

From all M. Cazenave's experiments, it results that only weighing as barium sulphate gives correct figures, either in an atmosphere of carbonic or not.

In consideration of these conclusions, we think that the volumetric estimation is sufficiently exact to give information on the quantity of sulphur absorbed in a juice, more especially as the comparative determinations by Mr. Zerban relate to the estimation by weighing barium sulphate with distillation.

Some chemists control the acidity of their juices alkalimetrically. This method of working may be useful, since it is comparative, but it cannot give an indication as to the sulphur added to the juice since the combined sulphur is not indicated.

Supposing that the figures for the iodometric and alkalimetric analyses, calculated into sulphurous acid, were the same, those indicated by alkalimetry would nevertheless be incorrect, for with the sulphurous acid free organic acids would be included also.

We have already published figures showing a difference of at least 50 per cent. by the alkalimetric method. According to our colleague Haddon, with phenolphthalein as indicator, he obtained without deducting the initial acidity of the juice 40 per cent. at least; whilst our colleague Pitot using litmus finds that the losses would be from 35 to 40 per cent. Since hitherto no proof has been furnished that the combined sulphurous acid is equivalent in acidity to the displaced acids, it seems to us to be preferable to adhere to the titration with iodine in order to have accurate information on the working of sulphitation apparatus.

Of these apparatus there are in Mauritius numerous types, which are more or less advantageous, but which compared to the Quarez are certainly inferior.

The following table indicates the advantage of controlling the acidity by iodine. By such a control it may be ascertained whether the burnt sulphur is utilized with profit; and from the figures found either the consumption of sulphur or the apparatus itself may be modified:—

	Sulphur, in kilos.	Sulphur burnt per litre of sulphited Juice, in grms.	Sulphited Juice, in hectolitres.	SO_2 in 1000 c.c. (by iodine), in grms.	SO_2 utilized per 100 parts of sulphur burnt.	Sulphitation Apparatus used.
I. 1907-08	16,500	0·37	446,956·19	..	..	Giffard.
1908-09	17,000	0·41	408,007·53	..	..	
1909-10	23,000	0·43	526,267·72	..	..	
II. 1907-08	13,775	0·63	216,775·00	0·85	66·6	Giffard.
1908-09	16,370	0·66	246,104·00	0·85	64·4	
1909-10	21,720	0·59	367,100·00	0·85	72·0	
1910-11	16,682	0·58	284,281·00	0·85	73·2	
III. 1908-09	11,900	0·40	294,203·35	..	..	Sulphur Box with 3 bodies, recuperating the gas in the middle body.
1909-10	12,100	0·34	355,141·90	..	..	
1910-11	12,600	0·42	296,693·16	..	..	
IV. 1907-08	24,850	0·55	445,662·29	..	..	Ditto.
1908-09	30,550	0·63	481,423·87	..	..	
1909-10	37,000	0·65	566,882·69	..	..	
V. 1910-11	10,425	0·64	160,448·14	1·08	84·3	Ditto.
VI. 1908-09	7,000	0·52	132,229·77	..	..	Icery apparatus. Sulphurous water.
1909-10	10,000	0·48	207,918·38	..	..	
1910-11	14,000	0·64	217,345·69	..	..	
VII. 1909-10	37,504	0·52	719,410·93	0·87	83·6	Sulphur Box.
1910-11	23,000	0·56	408,902·39	0·79	66·8	Ditto.
1910-11	7,995	0·62	129,176·62	1·08	87·8	Quarez apparatus.
VIII. 1909-10	26,000	0·39	655,948·28	0·70	89·6	Quarez.
1910-11	3,770	0·39	94,372·98	0·70	89·6	

ABSTRACTS, SCIENTIFIC AND TECHNICAL.*

FURTHER EXPERIMENTS WITH THE PAULY APPARATUS. *By J. J. Hazewinkel. Archief (Java), 1911, med. 50.*

The suspicion that decomposition of sugar, either in the form of inversion or from the destruction of reducing sugar (glucose), may occur as a result of passing the raw juice through the Pauly preheating apparatus, has been conclusively shown by the author to be groundless when steam pressures from 1·2 to 1·4 of an atmosphere are used (*cf.* this *Jl.*, 1911, 212). On continuing the investigations with steam pressures varying between 1·5 and 2·0 atmospheres, and employing exactly the same analytical methods (*loc. cit.*), the following results indicating the difference in the composition of the juice before entering and after leaving the apparatus were obtained:—

No.	Brix (Refractometrically).	Polarization, Difference.	Clerget, Difference.	Reducing Power, Difference.	Pressure of Steam, Atmospheres.
1	16·31	+ 0·22	+ 0·24	+ 1·60	2·0
2	16·23	+ 0 10	+ 0·05	+ 2·80	2·0
3	15·58	— 0·11	— 0·08	— 1·20	2·0
4	15·41	+ 0·01	+ 0·02	+ 3·20	1·5
5	12·70	+ 0·05	+ 0·06	— 0·80	1·8
6	14·68	— 0·08	— 0·07	— 1·20	1·7
7	16·41	— 0·28	— 0·17	± 0·00	1·8
8	17·00	+ 0·11	+ 0·09	+ 0·80	1·8
Average		± 0·00	+ 0·01	+ 0·65	1·8

From the average figures (given at the bottom of each column) it will be observed that in the cases of the direct polarization and of the Clerget values there is practically no difference. As to the small increase in the reducing power, this, the author considers, may be ascribed to unavoidable errors of sampling; especially as the differences in the polarization and Clerget values only average ± 0·00 and + 0·01. That this is so would appear to be confirmed by the following results for the glucose factor, in which the differences are practically of no account:—

Glucose Factors.	1	2	3	4	5	6	7	8
Entering the Pauly	8·50	7·36	8·33	7·53	16·81	11·25	9·20	7·11
Leaving ,,	8·36	7·47	8·40	7·73	17·11	11·31	9·31	6·93
Difference ..	—0·44	+0·11	+0·07	+0·20	+0·30	+0·60	+0·11	—0·18

In conclusion, the author expresses the opinion that "there need be no apprehension as to the general introduction of the Pauly apparatus into the Javan sugar industry, provided it be worked within the limits of temperature and pressure indicated in these researches."

THE INCREASE IN THE PURITY OF THICK-JUICE ON CONVERSION TO MASSECUITE. *By J. J. Hazewinkel. Archief (Java), 1911, aflev, 4, 104-106.*

Previously the author has expressed the opinion that an alteration in the apparent purity is not a reliable indication as to the occurrence or non-occurrence of inversion. In a certain Java factory, he has observed that the purity of sulphited thick-juice on being boiled to massecuite always rises some degrees, and that sometimes this increase is considerable, amounting even to 5°. Some of the analytical figures obtained were as follows:—

	Thick-Juice.		Massecuite.
Brix	51·12	..	91·85
Dry substance	50·00	..	90·00
Glucose factor	7·33	..	6·36
Apparent purity	84·74	..	86·56
True purity	88·0	..	87·60
Rotatory power of the reducing sugar	— 2·26	.	— 1·28

He further obtained the following figures, which are calculated on 100 parts of dry substance:—

	Thick-Juice.		Massecuite.
	102·24	..	102·06
Clerget value	87·96	..	87·63
Glucose (grav.)	5·84	..	5·63
Ash	1·84	..	1·79
CO_2 in ash	0·36	..	0·40
Gum	0·30	..	0·29
Undetermined organic matter..	4·42	..	5·06
	100·00		100·00

In discussing these results, it is pointed out that in such cases the errors of analysis may sometimes be high, and may appreciably influence the conclusions, but that here the indications are so striking that there can be no doubt as the way in which they should be interpreted. It is seen that in the massecuite there is a variation in the direction of a decrease in the levulose portion of the reducing sugar, and that at the same time there is a similar slight decrease in the polarization. Although the following calculated results for the direct polarization may be more of relative value, they are typical and worth noticing:—

Thick-Juice.		Massecuite.	
Pol. 87·96 per cent. sucrose..	87·96	Pol. 87·63 per cent. sucrose ..	87·63
,, 3·05 ,, dextrose (0·80)	2·44	,, 3·86 ,, dextrose (0·80)	3·09
Total pol.	90·40	Total pol.	90·72
Levulose 2·79 per cent. (1·34)..	—3·73	Levulose 1·77 per cent. (1·34)..	—2·37
Pol. direct (calculated)	86·97	Pol. direct (calculated)	88·35
,, (found)	86·64	,, (found)	88·36

That too much reliance should not be placed on purity values may be appreciated from the fact that levulose very readily decomposes, its levo-rotatory power and its reducing action both decreasing, so that the figure for the purity may be altered without the sucrose being affected.

INVESTIGATIONS ON CANE GUM. *By J. J. Hazewinkel and L. G. Langguth Steuerwald. Archief (Java), 1911, aflev. 11, 313-321.*

Of recent years it has become more and more apparent that the gum content of cane juice plays an important rôle in the complications occurring during the process of boiling, and for this reason it is very desirable to have an accurate method by means of which the amount of gum may be determined. Previously one of the authors (Hazewinkel, this *Jl.*, 1911, 222) has shown that the available method, that of Tervooren, for the determination of gum by precipitation with acidified alcohol is not satisfactory; the results varying considerably according to the relative proportions of sample, of alcohol, and of acid, especially of the latter, that may be used. Further investigations in this direction now elucidate the facts that (1) on filtering off the precipitate obtained by acid-alcohol, and further treating it with this reagent, organic matter is extracted in inverse proportion to the acidity of the alcohol; (2) that the more acid the acid-alcohol contains, the less precipitate is formed; and (3) that, on extracting the acid-alcohol precipitate with acid, there passes into solution some substance—the ash : organic matter ratio of which increases with the concentration of the acid. So as to obtain a more definite insight into the nature and amount of these gummy substances, the authors were led to determine the pentosan content of the precipitates obtained with different acidities, and they then found that: (1) acid-alcohol is capable of extracting from the precipitates a body yielding pentosans; (2) organic salts, decomposable by acid-alcohol, are not present in any appreciable amount; and (3) the precipitate obtained with variable quantities of acid contains different amounts of pentosan-yielding substances. On extending the pentosan method of examination to factory products, the fact was demonstrated that all the pentosans occurring in thick-juice are recoverable in the molasses obtained from such thick-juice. As regards raw juices, it was discovered that the pentosan content increases with the time that may have lapsed between cutting and milling, which would appear to bear out the assumption of an important correlation between the space of time from cutting to milling on the one hand and the nature of the mill work on the other, the figures obtained being:—

	Karang Redjo. No. 100		Krebert No. 100.			Karang Doeren No. 247.		
	After 3 days.	After 6 days.	After 1 day.	After 3 days.	After 5 days.	After 1 day.	After 3 days.	After 5 days.
Brix.. ..	17·7	17·0	16·7	17·1	18·1	16·6	16·7	17·0
Pol.	16·36	15·43	15·24	15·21	15·34	14·98	15·01	15·08
Purity ..	92·4	90·8	91·3	88·9	84·8	90·2	89·9	88·7
Pentosans.	0·039	0·060	0·041	0·052	0·068	0·038	0·044	0·050

On investigating the effect of methods of inbibition, it was found that so far as the pentosan content of mill juice is concerned hot and cold imbibition give the same results, but how far this may be true as regards pectins was not determined. Finally, the striking fact was observed that practically all the pentosans occurring in the juice come from the second and third mill juices, and that first mill juice contains almost none; the actual figures being for the mixed juice, 0·068; for the second and third mill juices, 0·053; and for the first mill juice, 0·015 per cent.

Chemical Control in the Cane Sugar Factory. *By L. Giraud. Bulletin (Mauritius), 1910, 1, 9-14.*

In the course of a paper delivered before the newly formed Society of Chemists of Mauritius, the speaker emphasized the importance of uniform methods of analysis for the chemist of the cane *sucrerie*. In discussing the sources of error in factory control, it was pointed out that the most common is that arising from a low measurement of the juice, an error, that appears to indicate that more sugar has entered the *usine* than has really done so, thus being produced. Baird estimates this error to be 0·2 per cent. of sugar on the cane worked, and shows that it is due principally to the influence of froth. For controlling the sugar entering the factory in the juice, periodic examination of the normal juice extracted per cent. of the cane should be made, while often false gauging may be recognised by observing the sugar contained in the weighed massecuite. A second cause of error is that due to the rapid alteration of samples of juice from the *usine*, when the weather is very hot, even although lead acetate may have been added to the assay liquid. It is suggested that by means of cooling baths juice might be maintained at 20° C., ammonium nitrate, which would be recoverable by evaporation, being used. Mercury salts and formaldehyde may be used for conserving the juice, but cannot be employed if the reducing sugar is also to be determined. The third source of error pointed out arises from the presence of levulose in variable proportions in the juice, the direct polarization thus being affected. In factories in which the juices are bad, this error may be as high as 0·2 per cent. of the cane; and so as to obviate it, the double polarization method of Clerget should be used, once a week at least, a correction being made being applied to the direct polarization for the other days. All these errors, which taken together may amount to 0·4 per cent. on the cane, appear to diminish the apparent richness of the cane, and to indicate that better working than reality prevails. In the latter part of his paper, the author called attention to the necessity of the frequent determination of densities and of the calculation of the dilution. However many bagasse analyses may be made, and however rapidly these may be carried out, they do not give sufficiently rapid information as to what

is taking place at the mills; whereas the dilution and density of the third mill juice may be of great use in this respect. So as to effect regular exhaustion of the bagasse, it is necessary to maintain this dilution at the same point. For the same amount of water added in the same factory, the dilution will vary according to the work of the first mill, and the nature of the cane worked, but the density of the third mill juice will vary but little.

DETERMINATION OF THE DENSITY AND THE CALCULATION OF THE DILUTION. *By P. de Sornay. Bulletin (Mauritius), 1910, 1, 9-20.*

After discussing the determination of the density of solutions of sulphurous acid, and of the calculation of the dilution, the author, in a paper communicated to the Society of Chemists of Mauritius, considered the question as to whether the water added to a juice is recovered by the formula established for the densities of solutions as found by the densimeter. It was pointed out that even with great care it was not possible to obtain a satisfactory result in any of the separate observations. With the Mohr balance, however, when the various causes of error are eliminated, which is not easy, it is possible to arrive at sufficiently accurate results. Thus:

20·10	in place of	20·0	per cent.	of water.
15·05	,,	15·0	,,	,,
10·02	,,	10·0	,,	,,

On the contrary, with the densimeter the differences are quite considerable, and may be either positive or negative; but if the average figures be taken of the separate observations, the differences then observable are insignificant:

Water added per cent. on Juice.	Initial Density at 15° C.	Density of the diluted Juice at 15° C.	Water found.	Water calculated, with density of water at 15° C.
15·0	1057·25	1050·00	14·5	14·2
19·0	1070·75	1059·75	18·4	18·1
20·0	1071·25	1059·00	20·7	20·4
20·0	1053·00	1044·75	18·5	18·0
25·0	1055·25	1043·75	26·2	25·7
19·8	1061·50	1051·45	19·53	19·16

With the picnometer, the results found were:

	Density.	Water found, per cent.
Water	....	..
Raw juice	1065·6	..
Raw juice + 10 per cent. water	1059·4	10·4
Raw juice + 20 ,, ,,	1054·6	20·1
Raw juice + 40 ,, ,,	1046·7	40·4

PUBLICATIONS.

THE SUGAR BEET AND BEET SUGAR. *Some suggestions as to how to increase the beet tonnage in field, and the sugar extraction in factory, and how to raise the capacity of a sugar mill.* By Samuel L. Jodidi, Ph.D. Beet Sugar Gazette Company, Chicago, Ill., U.S.A.*

Dr. Jodidi† has undertaken the praiseworthy task of setting forth in a series of cleverly written articles in the columns of the *Beet Sugar Gazette*, some of the details and the weak spots in the sugar beet industry that deserve full attention from the parties interested, especially in the United States. These articles, though hardly forming a homogeneous *ensemble*, have been collected and reprinted in a separate booklet, which, while of no great size, is well worth reading, and can be taken to heart by those for whom it was prepared. Whereas 20 years ago‡ practically no beet sugar industry existed in the States, the nation can feel proud that in such a short lapse of time 63 factories have sprung up, working 3,000,000 tons of beets, grown on 370,000 acres, into 421,000 tons of sugar. Yet, comparing the United States average yields with those of Europe, Dr. Jodidi finds it necessary to attempt some explanation of the causes that possibly lead to the following differences:—

	1908-09.		1907-08.		1906-07.	
	Tons of Beets per acre.	Per cent. Raw Sugar extracted.	Tons of Beets per acre.	Per cent. Raw Sugar extracted.	Tons of Beets per acre.	Per cent. Raw Sugar extracted.
Average of Europe	11·0	10·5	10·9	14·9	11·6	14·8
,, U.S.	8·1	12·6	9·2	12·3	10·2	11·4

Subsequently he gives for the benefit of the United States beet-growers certain fundamental truths about soil cultivation, manuring, seed, &c., that should be mastered in order to make beet growing a financial success.

While giving full credit to this able writer, we would like to make a few comments. Rightly he points to the value of good seed, but he might have dwelt a little more on those qualities of the seed which cannot be seen externally. Is chlorine really so harmful for the sugar

* Copies may be procured from this *Journal*, price 2/- paper and 4/- cloth, post free.

† Having had a thorough scientific training in Germany, Dr. Jodidi is entirely familiar with the practical side of sugar manufacturing, his knowledge being acquired in a series of campaigns in both cane and beet sugar factories; he is at present attached to the Michigan Experiment Station.

‡ The first unsuccessful attempts in the United States date from 1830, and the first successful ones from 1870; in 1890 the industry took a firm foothold and developed rapidly. In the Eastern States non-success has been the rule, while in the Western and far West, credit should be given to the many thrifty old country farmers.

beet?* In Zeeland a few years ago some polders were inundated by the sea. After the flood had subsided sugar beets grew very well on that soil and had good sugar content. Again, is it advisable to try to further increase the sugar content?† Would not the high-bred beetstrains become still more liable to diseases?

A chapter (written by Dr. Townsend in the service of the United States Government) on the utilisation of by-products increases the value of this little book; but the list does not include that by-product the "tare-earth" or soil washed off the carted beets before slicing begins. We know one instance where this has been emptied into a river and afterwards has had to be dug out at considerable cost. As Dr. Jodidi points especially to those matters in which the United States farmers have been more or less deficient, we can recommend the perusal of his work to those British farmers who have tried the new agriculture but have not made it a financial success. We must add that, having regard to the price, the get-up of the book might have received more consideration, and some illustrations (out of the endless number in the hands of the publishers) might well have been spared to add to it.

E.K.

England's Foundation: Agriculture and the State. By J. Saxon Mills. London: P. S. King & Son, Orchard House, Westminster. 1s. net.

"This extremely interesting little book (to quote the Earl of Denbigh, who contributes the *Preface*) is a valuable contribution to the consideration of one of the most important home problems confronting us," which, in short, is the resuscitation of our old agricultural prosperity. The story of the decline in our agriculture is told in a few pages, and figures are given showing the invariably decreased area under cultivation of every commodity—be it wheat, barley, oats, hops, or other green crops. Mr. Mills would restore our country to its old position as a larger producer of the corn needed for our bread, and for that reason demurs to the suggestion that Colonial wheat at least should come in free. To clinch the argument, emphasis is laid in one chapter on the deplorable condition our food markets would be in within a few weeks of the outbreak of war, as there is said to be never more than six weeks' supply of food in the United Kingdom. Needless to say, Lord Denbigh puts in a word in his *Introduction* for the beet sugar industry he would like to see established in this country.

---

* Perchlorate of potash has proved poisonous, but Strohmer's trials with Na Cl manuring have not shown that bad influence is to be feared.

† According to Briem the limit is fixed by the tension within the cells; for 1 per cent. of sugar at 15° C. is figured 0·69 atmospheres by the plant physiologist Pfeiffer.

Results obtained in the Study of the Froghopper during the Wet Season of 1910. By Lewis H. Gough, Ph.D., Trinidad Department of Agriculture, Circular No. 8; 46 pp. illustrated.

A general review of the present state of knowledge of the life-history of the froghopper, its effect on canes and the methods of controlling the pest: detailed references are made to a rather extensive bibliography on the subject.

An Ideal Tariff and the Constitution. By R. V. Wynne. London: P. S. King & Son. 1911. 104 pp. 1s. net.

An argument for free trade within the Empire and a tariff on foreign commerce; illustrated by the practice of the German Zolverein and the United States Union.

CHART showing the Imports of Refined Sugar, Raw Sugar, Total of all kinds and Proportion of Refined each Year: the Import per Head each Year: The Highest and Lowest Prices of Tate's Cubes and 88 per cent. Beet, f.o.b. each Year from 1860 to 1910. Compiled by Lionel A. Martin. Tate and Sons Ltd., London and Liverpool. (A copy will be sent free to any of our readers applying to the publishers for the same.)

Diseases of the Pineapple. By L. D. Larsen, Bulletin No. 10, Pathological and Physiological Series of the Hawaiian Sugar Planters' Association Experiment Station. 77 pp. and index illustrated. Honolulu, 1910.

A bill has been passed in the Greek Assembly authorizing the Government to postpone for two years the introduction of the State Sugar Monopoly Law.

It is said there are 8000 men employed in the sugar industry in Natal, the number of factories being 34 and representing a capital of more than £1,000,000.

The cane variety D 1135, which was some years ago imported from Demerara to Queensland, is stated to be rapidly replacing all other varieties owing to its good yield and resistance to drought and frost. Its yield in 1909-10 for the whole of Queensland was 19·8 per cent. sugar, with a purity of 93·7.

UNITED KINGDOM.

IMPORTS AND EXPORTS OF SUGAR

To End of April, 1910 and 1911.

IMPORTS.

Unrefined Sugars.	1910. Tons.*	1911. Tons.*	1910. £	1911. £
Russia	....	....	....	....
Germany	86,281	206,015	1,162,447	2,060,348
Netherlands	4,581	3,454	54,816	31,384
Belgium	2,872	3,450	35,207	33,020
France	409	44	5,864	393
Austria-Hungary	36,655	33,437	489,938	332,498
Java	101	6	1,104	66
Cuba	16,890	1,544	230,152	12,524
Dutch Guiana	2,722	3,199	38,294	37,142
Hayti and San Domingo	32,296	11,600	453,116	121,577
Mexico	3,956	2,249	56,708	26,125
Peru	24,714	13,998	333,251	129,118
Brazil	24,526	2,153	294,747	17,252
Mauritius	10,839	13,860	149,294	117,934
British India	593	....	6,276	5
Straits Settlements	655	....	7,769	....
Br. West Indian Islands, Br. Guiana & Br. Honduras	29,915	18,972	429,958	256,134
Other Countries	7,435	6,882	95,596	64,690
Total Raw Sugars	285,438	320,864	3,844,537	3,240,210
Refined Sugars.				
Russia	94	18,229	1,452	218,272
Germany	126,407	136,878	1,944,536	1,755,343
Holland	31,228	41,048	498,386	555,549
Belgium	9,486	11,625	157,805	158,598
France	30,327	1,932	488,517	28,203
Austria-Hungary	64,971	65,306	1,034,295	851,988
Other Countries	13,083	78	219,454	955
Total Refined Sugars	275,595	275,094	4,344,445	3,568,908
Molasses	59,770	43,705	280,044	174,803
Total Imports	620,803	639,663	8,469,026	6,983,921

EXPORTS.

British Refined Sugars.	Tons.	Tons.	£	£
Denmark	1,291	1,384	17,718	15,654
Netherlands	1,139	917	17,417	11,995
Portugal, Azores, & Madeira	403	513	5,477	5,756
Italy	116	592	1,566	6,756
Canada	1,576	2,363	24,419	33,978
Other Countries	2,617	4,789	48,132	71,906
	7,142	10,557	114,729	146,045
Foreign & Colonial Sugars				
Refined and Candy	184	334	3,474	5,140
Unrefined	1,229	3,287	17,179	37,263
Various Mixed in Bond	30	....	480	....
Molasses	146	75	1,061	417
Total Exports	8,731	14,253	136,923	188,865

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1911. Tons.		1910. Tons.
Total Receipts January 1st to April 29th	786,212	..	953,768
Receipts of Refined ,, ,, ...	227	..	132
Deliveries ,, ,, ...	761,847	..	917,147
Importers' Stocks, April 26th	24,365	..	39,971
Total Stocks, May 3rd	216,000	..	366,550
Stocks in Cuba, ,, ...	334,000	..	396,000
	1910.		1909.
Total Consumption for twelve months ..	3,350,355	..	3,257,660

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR FOR 1909, 1910 AND 1911.

(Tons of 2,240 lbs.)	1909. Tons.		1910. Tons.		1911. Tons.
Exports	559,146	..	674,706	..	533,711
Stocks	346,855	..	399,231	..	378,662
	906,001	..	1,073,937	..	912,373
Local Consumption (3 months) ..	16,350	..	16,890	..	17,040
	922,351	..	1,090,827	..	929,413
Stock on 1st January (old crop) ..	....	..	....	..	....
Receipts at Ports up to 31st Mar.	922,351		1,090,827		929,413

Havana, 31st March, 1911. J. GUMA.—F. MEJER.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION OF SUGAR FOR FOUR MONTHS ENDING APRIL 30TH.

	Imports 1909. Tons.		Imports 1910. Tons.		Imports 1911. Tons.	Exports (Foreign) 1909. Tons.		Exports (Foreign) 1910. Tons.		Exports (Foreign) 1911. Tons.
Refined	380,867	..	275,595	..	275,094	286	..	184	..	334
Raw	231,379	..	285,438	..	320,864	1,024	..	1,259	..	3,287
Molasses	53,070	..	59,770	..	43,705	50	..	146	..	75
	665,316		620,803		639,663	1,360		1,589		3,696

	Home Consumption 1909. Tons.		1910. Tons.		1911. Tons.
Refined	384,495	..	265,935	..	259,729
Refined (in Bond) in the United Kingdom........	216,418	..	194,421	..	206,211
Raw	45,241	..	40,277	..	33,66
Molasses	46,711	..	56,109	..	41,053
Molasses, manufactured (in Bond) in U.K........	26,603	..	25,988	..	27,164
Total..........................	719,468	..	582,730	..	567,820
Less Exports of British Refined.................	8,882	..	7,142	..	10,557
	710,586		575,588		557,263

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, APRIL 1ST TO 30TH COMPARED WITH PREVIOUS YEARS.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1911.
135,950	1,328,540	374,580	613,720	264,000	2,716,790

	1910.	1909.	1908.	1907.
Totals ..	..2,208,530..	2,594,510..	2,746,180..	2,859,380.

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING MARCH 31ST, IN THOUSANDS OF TONS.

(Licht's Circular.)

Great Britain.	Germany.	France.	Austria-Hungary	Holland, Belgium, &c.	Total 1910-11.	Total 1909-10.	Total 1908-09.
1912	1311	729	631	237	4820	4780	4564

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1910-1911.	1909-1910.	1908-1909.	1907-1908.
	Tons.	Tons.	Tons.	Tons.
Germany	2,602,000 ..	2,027,000 ..	2,082,848 ..	2,129,597
Austria	1,570,000 ..	1,257,000 ..	1,398,588 ..	1,424,657
France	740,000 ..	801,000 ..	807,059 ..	727,712
Russia	2,115,000 ..	1,145,000 ..	1,257,387 ..	1,410,000
Belgium	285,000 ..	250,000 ..	258,339 ..	232,352
Holland	225,000 ..	198,000 ..	214,344 ..	175,184
Other Countries .	590,000 ..	460,000 ..	525,300 ..	462,772
	8,127,000	6,138,000	6,543,865	6,562,274

THE

INTERNATIONAL

SUGAR JOURNAL.

No. 150. JUNE, 1911. Vol. XIII.

☞ All communications to be addressed to the Editor, Office of "The Sugar Cane," Altrincham, near Manchester. All Advertisements to be sent direct.

☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

Cheques and Postal Orders to be made payable to NORMAN RODGER, Altrincham.

The Editor will be glad to consider any MSS. sent to him for insertion in this Journal and will endeavour to return the same if unsuitable; but he cannot undertake to be responsible for them unless a stamped addressed envelope is enclosed.

NOTES AND COMMENTS.

The Coronation of King George.

June, 1911, is surely a red letter month throughout the British Empire as it witnesses the Coronation ceremonies of our King and Emperor, George the Fifth, with their usual accompaniment of loyal display and national rejoicing. The quiet interval between his succession to the throne and his coronation has surely served its purpose well. When Edward the Seventh passed away with almost tragic suddenness after all too short a reign, there was a general feeling of uncertainty as to what the calibre of his successor would prove. The Prince of Wales, as King George then was, had not hitherto loomed large in the public eye, and little was known, at least by the man in the street, of his powers of statesmanship and his abilities as a ruler; but any fears that might have been felt on this score were from the first quickly dissolved, and the new King and his gracious Consort soon established themselves in the popular favour. If King George has not the same personal magnetism and commanding presence that distinguished his father, he has nevertheless attributes that are endearing him to the hearts of his people, and we can look forward confidently to his making his power felt as a wise and benign ruler; and we can therefore pray in sincerity that God save and bless our King.

With the prospect of the Celebrations in store, visitors, representative and non-representative, have been flocking to the old country from all parts of the Dominions to have a share in the rejoicing. Among them not a few sugar planters are to be found; and we know of one colonist who, after 43 years of agricultural life in South Africa, has just come over to England for a holiday. One would like to know his impressions of the changes he finds established since he was last over here. London of 1911 must certainly be a revelation to one who has only known it as it was in 1868. Mechanical traction has revolutionized the traffic conditions of our streets; not altogether for the best perhaps, but nevertheless the saving in time thereby gained must represent no inconsiderable period of a busy man's life. And the modern hotel with its luxuries, such as private bathrooms, telephones, orchestras, book stalls, and post offices, must be a considerable advance on the type of caravanserai that the mid-Victorian era provided.

Mr. Hal Williams on Beet Sugar Factories.

At a recent meeting of the Royal Society of Arts, Mr. Hal Williams, M.I.M.E., gave a popular lecture on Beet Sugar Factories, illustrated by limelight views of sugar factory scenes in France and Belgium, and of sugar machinery within the factories. He showed his sympathy at the outset with the attempts being made to grow beet commercially in the United Kingdom, emphasizing the fact that on the Continent this cultivation pays very well indeed. Dealing with the matter of evaporating plant in the factories, the lecturer stated that the ordinary triple and quadruple effect pans worked under vacuum are being rapidly replaced by the much more efficient Kestner climbing film evaporator, working either under vacuum or with pressure; all the evaporation done under pressure has given extremely efficient and satisfactory results. In fact, in Mr. Williams' opinion, it would not be too much to say that M. Paul Kestner has worked a revolution in the rapidity and economy with which evaporation takes place. In the ordinary type of evaporator the liquor to be evaporated has to remain in the vessel until the required density is reached. This is frequently a period of some hours, and the effect on the sugar juice of so long an exposure to heat is deleterious. In the Kestner evaporator, on the other hand, it passes through in a continuous stream, remaining in the evaporator, and consequently in contact with the heated tubes, for a period of only about five minutes. The pressure-evaporator has a pressure of anything up to 40 or 60 lbs. and instead of a vacuum, the vapour is taken away at a pressure of from 1 to 10 lbs. The juice so treated is clearer and brighter, and produces better sugar than when treated under a vacuum.

Dealing with factory design, the lecturer expressed the opinion that a very good and useful size is one capable of dealing with 500 tons of

beetroot per 24 hours. Such a factory would cost about £60,000 and would be able to deal with 40,000 tons of roots in a campaign of about 80 days, or the product of say 2,500 to 3,000 acres, an amount of land which could easily be spared from grass growing.

Sugar Cutting Machinery.

A perusal of the sugar papers of Louisiana and Queensland reveals from time to time the efforts that are being made by sundry inventors to devise a competent cane-harvesting machine, and ever and anon we are informed that one has at last been produced which is to revolutionize harvesting; the revolution, however, never seems to materialize. The fact is, there are difficulties encountered which so far no one has succeeded in successfully surmounting, and there are not wanting experts pessimistic enough to express their doubts whether success will ever be achieved. That there is a continuously increasing demand for such machines owing to scarcity of labour cannot be gainsaid; and one has only to point to the expenditure some engineers have incurred in the course of experiments to realize that there has been no lack of effort to supply the demand. But the difficulties are great. As the *Louisiana Planter* points out, the Louisiana Sugar Planters' Association offered a reward as far back as the eighties of a thousand dollars or more to the first inventor whose apparatus submitted for this purpose should meet with the approval of a committee of the Association. Since that time hundreds of thousands of dollars have been expended by various inventors in their endeavours to perfect such a machine, and thus far they have apparently only approximated actual success. Several machines are now, or were very recently, offered to the planters with certain guarantees as to their work, but none has yet gone through a season's work and come out triumphant. "It would certainly be unwise to say that it is impossible to perfect a cane-cutting machine, but it will unquestionably call out in the future, as it has in the past, the outlay of a very considerable amount of money and of much inventive talent. The problem is a far more difficult one than that of the wheat harvester, or of the more recently constructed corn harvesters."

As some indication of what has been done experimentally, the *Louisiana Planter* refers to work undertaken by Mr. Cockrell, of Missouri, who spent some $50,000 in his experiments and has now seemingly abandoned them; to the efforts of Mr. Hadley, of Indianopolis, who has been engaged in this matter for a number of years and has been expending large sums of money and now claims to have made a success in Cuba during this last season; and to the efforts of Mr. Luce, whose machine at Audubon Park some months back gave what seemed to be evidences of a nearer approach to final success than any other machine experimented with there thus far. "The stumbling block," says the *Planter*, "with all of these has been the attempt to

automatically free the canes from the leaves and the super-abundant top and to cut the top off at the proper point. Mr. Jules Gaussiran's machine, invented quite a number of years ago, has been quite successful in cutting the cane at the ground line and thus in successfully windrowing it as a prevention against frost or windrowing it for seed, as is done in the sugar districts of Louisiana, where the cane is laid down in furrows and covered lightly with earth for use in planting some months later."

Paper from Megass.

As enquiries are continually coming to hand for information regarding the manufacture of paper from megass, it is as well to inform our readers that while the attempts to achieve successful manufacture have been more numerous of late years, they do not seem to have met with any greater measure of success than have earlier ventures, of which there have been instances at regular intervals during the last twenty years. According to the expressed opinion of the inventors, the time was invariably ripe for such a paper industry, and calculations were always advanced to show what lucrative profits might be expected if the planters would start a megass paper manufactory. Yet in spite of all the promises, there has been no sign of real progress. Occasionally samples of good paper have been produced, and in 1880 we believe one issue of the "Louisiana Planter" was actually printed on such paper. But nothing has been heard of the manufacture on a commercial scale, and we fear it will be some time yet ere a practical scheme can be evolved that will compete successfully with the existing paper-making processes. Still with the present huge demands for paper and the feared famine in wood pulp at some not distant date, it is to be assumed that extended attempts will be made in the near future to see what can be done with megass as a raw material.

Sugar Making in Natal.

There seem to have been few events in the industrial history of Natal to equal in importance the recent opening of Messrs. J. L. Hulett & Sons' new sugar refinery at South Coast Junction, and there was quite a representative gathering from all parts of the Colony. We understand that quite £160,000 has been expended on this new refinery, and the whole contract was efficiently carried out by one Glasgow firm, the Harvey Engineering Co. Ltd., who by their persistent efforts and unwavering faith in the future of the South African sugar industry have certainly secured the lion's share of Natal sugar machinery orders. For, in addition to this large sugar refinery, they have constructed for Messrs. J. L. Hulett & Sons, Ltd., four large central sugar factories, viz., Tinley Manor and Darnall, in Natal, also Amitikulu and Umhlatuzi, in Zululand. These factories are all up to date in every way, and the last and largest factory (Umhlatuzi, in Zululand)

has all the latest improvements known in cane sugar making—multiple crushing, central condensation, and many other means wherby labour in the factory is considerably reduced.

The new buildings (we glean from a Natal paper) are more or less five stories in height. The raw sugar store has three flats which are inter-connected by a hydraulic elevator; in fact, there are similar lifts to all parts of the buildings. The melting-house is placed next to the new sugar store, and here the raw sugar is melted down, that being the first stage of the refining process. In the melting house a number of large tanks are provided for storing raw syrup to be converted into "Hulett's Golden Syrup." There are three melting pans, each with a capacity of five tons. From these the sugar in its liquid state is transferred to a set of Taylor's bag filters. Special rotary washing appliances are used for cleaning the filter bags, when they become saturated with sugar offal know as "slug," and in order that there shall be no waste, special machinery is provided which purifies the "slug" under a severe process, and then returns it to the melting pans. The "char" cisterns, in which the syrup is treated with charcoal in order to purify it, are enormous vessels. There are 26 of them, and each has a capacity of 25 tons. In the "char" cisterns the sugar syrup receives its final touch in the refining process, then follows the crystallizing process, ending up with the centrifugal and granulating or drying, before the refined article is finally bagged and placed on the market. Each of the 26 "char" cisterns has a distributing pipe conveying the syrup to the troughs which communicate with the three large vacuum pans. There are two immense revolving crystallizers and four large granulators, or drying cylinders. In the last mentioned appliances hot air is collected from radiator fixtures, and fanned into the granulators by electric fans. The sugar, which enters the granulators in a rough and damp crystallized state, comes out beautifully dry, and granulated fine as table salt. Then the sugar is bagged, weighed automatically, and placed on the market.

At a luncheon given in honour of the opening ceremony some interesting speeches were made. Sir Liege Hulett, head of the firm said that there were a few in the Province who, if they did not remember absolutely the start of sugar-growing in Natal, were yet early enough there to be acquainted with the facts. The first sugar produced in Natal was grown by Mr. Morwood, on what has since been called Morwood's Flats, between the Tongaat River and Umhlali. His machinery consisted of two wooden rollers and a sort of Kafir pot for the making of sugar. Mr. Morwood left the Colony, but his mantle fell on the shoulders of others who came, and sugar began to play an important part in the early industry of Natal. Better machinery was introduced, and they had done something for the sugar industry, which had culminated in that refinery. In conjunction with their fellow-manufacturers they looked at the matter

in this light, South Africa must be self-contained, must have its own sugar, and must not take any sugar from any other country. They must grow sugar for their own needs, and take their surplus, if they have any, to the world's markets. Five or six years ago, he went on, 40,000 tons of sugar were manufactured in Natal. In the last season the Province produced 82,000 tons, and they would have 90,000 produced in the next. The consumption of sugar in South Africa was large, and they were going to cater for that consumption. The consumption was going to increase, and they were going to meet the demand, no matter whether that demand was doubled or trebled. The result of their enterprise was that inducement was given to producers of sugar to increase their output, in consequence of the expansion of refining power in the country.

Relative Capacities of Double and Triple Effects.

Professor E. W. Kerr, of Louisiana State University, had in a recent issue of the *Modern Sugar Planter* a paper dealing with the relative capacities of double and triple effects, and showing what gain may be expected from the conversion of a double into a triple effect. The capacity of evaporating apparatus of the kind under consideration depends upon the number of heat units that can be transmitted through the heating surface in a given time. Other things being equal, the number of B.T.U. transmitted per square foot of heating surface per hour depends upon the difference in temperature between the steam on one side of the heating surface and that of the juice on the other side. Professor Kerr shows by means of simple calculations that the theoretical heat transmission and therefore the capacity will be the same for the triple effect as for the double effect. Therefore in order to get a greater capacity from the triple it would be necessary either to increase the temperature drop or to increase the value of the coefficient of heat transmission. The former may be done by increasing the pressure of the steam supplied to the first body, or by increasing the vacuum in the last body. In practice it has been found that a double effect, with a steam pressure of five pounds per square inch and a vacuum of about 26 inches of mercury, will evaporate from seven to nine pounds of water per square foot of heating surface per hour, and that a triple effect will evaporate from five to seven pounds per square foot of heating surface per hour. Taking the averages at eight and six pounds respectively and remembering that the heating areas of the double and triple are to each other as 2 to 3, their capacities would be to each other as 8×2 is to 6×3, or as 16 is to 18, showing a small margin of capacity in favour of the triple. Such increase with a triple can, however, only be brought about by its having more favourable conditions than the double effect as regards temperature drop. In fact, other conditions

being equal, the triple effect would be at a disadvantage on account of the larger surface exposed to the atmosphere and therefore causing more loss due to radiation.

It is plain, therefore, that the advantage of a triple effect over a double effect is in its greater economy in the consumption of steam and not in increased capacity. In order to show this clearly, let us consider the evaporating plant of a 1,000 tons per twenty-four hours factory. Assuming that the extraction is 75 per cent. based on the weight of cane, that the added maceration water is 10 per cent., and that 75 per cent. of the water in the juice is driven off in the effects, it is easy to calculate the weight of water that must be removed per 24 hours and per hour. The latter works out at about 53,120 pounds per hour. Theoretically a double effect would evaporate about two pounds, and a triple effect about three pounds of water for every pound of steam supplied to the first effect. Actually, however, less than this is evaporated on account of the lost heat due to radiation. It may be assumed that there will be an actual evaporation of 1·9 and 2·85 pounds of water per pound of steam supplied to double and triple effects respectively. The steam per hour for the double effect would therefore be $53{,}120 \div 1{\cdot}9 = 28{,}000$, and that for the triple effect, $53{,}120 \div 2{\cdot}85 = 18{,}920$. This would give a saving of 9080 pounds of steam per hour due to the use of a triple as compared with a double effect.

International Congress of Applied Chemistry.

It is announced that the Eighth International Congress of Applied Chemistry will, by invitation of the United States Government, meet at Washington in September, 1912. The object of the assembly is, as stated in the preliminary announcement, the advancement of all applications of chemical science to practical life. Membership is open to any interested persons; application should be made to the secretary, Bernard C. Hesse, Ph.D., 25, Broad Street, New York, the membership fee being $5. All papers to be read should be in the hands of the committee by July 1st, 1912, and should preferably be typewritten; each paper must be accompanied by an abstract thereof. The most interesting section to our readers is naturally that relating to the "Industry and Chemistry of Sugar." The president of the section is Dr. W. D. Horne; the vice-president, Dr. Wiechmann; and the secretary, Dr. C. A. Browne, junr., 80, South Street, New York.

Sugar Cane Cultivation in Egypt.

Sir Eldon Gorst's report for 1910 states that the cultivation of sugar cane in Egypt shows a further satisfactory increase. Under favourable climatic conditions, the supply in 1909-1910 (up to November, 1910) amounted to 515,000 tons of cane, as compared with 359,000

tons in 1908-1909, and 253,000 tons in 1907-1908, and the percentage of yield was a high one.

The cultivation of sugar cane is increasing in Upper Egypt, notably at Nag Hamadi, Erment, and Kom Ombo, but there has been a slight decline in Middle Egypt, where the sugar-growing area is being invaded to some extent by cotton and wheat. This may be due to the fact that sugar cane occupies the land for such a long period that, after harvesting, there is no time to grow another crop while water is yet available. It has been found that if the water supply is sufficient for the cultivation of cane, it is equally so for a crop of cotton, followed by wheat or berseem, which combination is said to give a rather better return.

A variety of cane known as Java No. 105 has been introduced with somewhat conflicting results in different parts of the country, and experiments are being conducted by the Société Générale des Sucreries et de la Raffinerie d'Egypte with other new varieties from Mauritius in order to establish an improved type.

The British Beet Sugar Council.

In a recent communication to the press, the British Beet Sugar Council has been making an urgent appeal for funds to carry on immediate work of an educational, experimental, and advisory nature in connexion with their efforts to establish a beet sugar industry in Great Britain. They stated that an application had been made for a grant from the Development Fund, and an extremely favourable reply had been received from the Commissioners to the effect that "they have had before them the application of the National Sugar Beet Council for a grant from the Development Fund, in respect to which they had the advantage of hearing evidence from Mr. G. L. Courthope, M.P., at their last meeting. The Commissioners are carefully considering what ought to be done, and can properly be done from public funds, to encourage the cultivation of sugar beet in this country, and meanwhile they would wish to defer coming to a decision on the application immediately before them."

Prizes amounting to nearly £20 are being offered to Cheshire beetgrowers during the coming season by the County Beet Sugar Committee. More than 20 entries have been announced so far for the competition. In Cornwall the Beet Founders Ltd. of Liverpool are also offering a similar amount in prizes as some incentive to farmers to experiment in beetroot growing.

SUGAR IN INDIA.

II.

It is only during recent years that the Government of India have produced any definite statistics of that hitherto unknown—or little known sugar production. We can remember, in the old days, the crop of British India being spoken of vaguely as about three million tons, but now we have definite figures given to us, and they make their appearance, rather inconveniently, in some statistical publications. They may, by courtesy, be called definite, but in point of fact they are very indefinite, as may be seen when analysing them. But this does not mean any denial of the fact that the greatest credit is due the Indian Government for the effort to bring our Indian Empire, so far as sugar is concerned, into the world's statistics. The Director-General of Commercial Intelligence has now issued, from the office in Calcutta, the third edition of his most excellent and exhaustive treatise on the subject.*

In this interesting book Mr. Noël-Paton gives us a mass of valuable information in a very readable form. It will not be possible here to do more than glance at some of its salient features. A letter in the columns of *The Indian Agriculturist* of April 1st, 1911, leads up, very conveniently, to our first criticism by pointing out that sugar manufacture in India has, in the past, been carried on successfully on a large scale. The following passage is worth noting :—

> "Let me first quote what the father of Indian Botany, Roxburgh, said when he discussed the item after many years' practical experience. I quote the 'Asiatic Annual Register' for 1802, a volume of which one half should be reprinted. Roxburgh gives in detail the system of cultivation in Rajahmundry and Ganjam districts; he mentions that 'about Aska the natives make most excellent sugar.' Now at Aska the sugar king for many years carried on his manufacture of sugar and rum, introducing all the improvements that Roxburgh suggested and many more; some of us had the advantage of learning from Mr. Minchin himself what he had done, his successes and his failures."

The present writer had the great pleasure and privilege, forty years ago, of accompanying Mr. Minchin in a very interesting tour among the sugar factories and machine works of the European beetroot districts. He was an eager learner, a patient listener, and a capable "sucker-in" of all that we saw and heard. We finished up with a charming visit to Julius Robert, the inventor of the diffusion process, whose faithful disciple Minchin had been for many years. Here is a man who took the trouble to go about the world and see for himself what was going on, and then to go and do likewise. We can

* Notes on Sugar in India, by Frederick Noël-Paton, Director-General of Commercial Intelligence, India. Third Edition, 1911.

recollect Aska sugar—beautiful white large-grained crystals—in Mincing Lane in the sixties. There is, therefore, no reason, provided that conditions can be found elsewhere as good as they are in Ganjam, why India should not produce for herself the 600,000 tons of white sugar which she now annually imports from Java, Mauritius, and Austria. The writer in *The Indian Agriculturist* might well call Minchin "the sugar king."

It is quite right that Mr. Noël-Paton should devote Chapter X. to the results of the centralized estate system, by going through the great transformations in Formosa, Mauritius, the West Indies, and the Hawaiian Islands, but he should follow up this examination by ascertaining how far the work of Minchin, Messrs. Parry & Co., and others in India could be practically extended in other directions. It is only by a survey of the country that any idea can be formed as to the possibilities for combined action and concentration of work. Minchin knew all the native growers round about him, and got canes from some and jaggery from others to keep his factory at work. But that can only be done by a man like "the Sugar King."

The whole of Mr. Noël-Paton's essay is well worth reading. The early history of sugar, the international negotiations, the legislation and bounties in Europe, and the sugar cartels, are dealt with very fully, but the real essence of the subject comes out in the chapters on the Indian sugar crop and Indian sugar production. He begins by admitting that "up to the present India's true position in the world as a sugar producing country is indeterminate." All figures anterior to 1890-91 have no very great value, "while those for later years are subject to the defects inherent in crop estimates in every part of the world." We fear they must be regarded as much more defective than the fairly accurate estimates now made of sugar crops in most countries. For instance many of the native States give us no return. Again, the crop of sugar per acre is a pure guess of 1·25 tons. The number of acres is also only a rough estimate, and of the canes grown on those acres a considerable quantity will "continue to be chewed in the natural state."

However, be the defects of the estimates what they may, it seems conclusive that since 1899 there has been a falling off in the acreage devoted to sugar. The estimated area under cane on the average of the three years ending 1899-1900 was 2,699,363 acres, while that for the three years ending 1909-10 had fallen to 2,372,338 acres. If the sugar be worked out on a basis of 1·25 tons per acre this means a reduced production of 408,782 tons of sugar. Curiously enough this figure very nearly agrees with the increase, during the same period, in the importation of foreign (white) sugar, which was 397,009 tons. Other reasons for the reduced cultivation of sugar may be found in the fact that the value of other crops has gone up, while the value of sugar, owing to the foreign competition, has gone down.

Passing from cane sugar to palm sugar we find, again, a very rough and ready method of estimating a total production. In Bengal, the yield of palm sugar "has been roughly estimated at 125,300 tons; and if it be assumed that this estimate is adequate and that the ratio of Bengal's cane sugar to that of all British India holds good in respect of the palm, a total of some 480,200 tons is derived from this secondary source." We can remember, in the old days, buying palmyra jaggery (palm sugar), but we had no idea that India produced such quantities. But then, as Mr. Noël-Paton points out, what with the cane that is chewed, and the gûr that is eaten as food, the greater part of the sugar production of India will fail to "come into sight commercially."

What India really requires, therefore, with regard to sugar is to be able to produce sufficient high-class (*i.e.*, white) sugar to supply, from its own fields and factories, the 600,000 tons which are now imported. The demand for this class of sugar is likely to go on increasing, "for the large imports of good sugar at low prices in recent years have had the result of creating in the country such a demand as would not, under other conditions, have arisen in a long period." A country which grows cane enough to produce nearly 3,000,000 tons of sugar should not import half-a-million tons of white sugar merely because it does not know how to make it. Let the Government officials go down to the Aska factory in Madras (if it still exists) and see for themselves how the factory is worked, and how it is supplied with its raw material. It may be that in other parts of India the cane fields are not sufficiently concentrated to make it possible for a central factory to obtain a constant supply of canes. Let them do as Minchin did, work cane juice and jaggery combined.

Here we can make a suggestion which may be useful. It may be possible to induce the peasant, who works a primitive mill and boils his juice down in an iron pot till it crystallizes into a solid mass of black sugar called *jaggery*, to permit some slight improvements in his machinery, especially if he found that it brought him more profit. The mill might be improved, even to the extent of a three-roller horizontal mill driven by a small engine. The clarification of the juice could be easily improved without any great expense or complications. Lastly, the crystallization—or rather, the solidification—of the juice could be carried out in a Fryer's concretor. The result would be, as before, a solid mass—no longer black, but clean bright yellow. The people would no doubt eat it with avidity; but the great advantage would be that it could be conveyed—no matter the distance—to the nearest central factory and converted into white sugar with much greater ease than in the case of jaggery. This appears to be the most likely line of policy to bring about practical results. Canes cannot be carried long distances, especially in a tropical climate, but Fryer's concrete will go anywhere. If, as we

suggest, the canes be well crushed in a three-roller mill while they are fresh, the juice well defecated by simple well-known methods, and then rapidly concentrated by the Fryer concretor into a solid mass which has not been injured, either in colour or composition, by overheating, then you have in solid form a good fair average percentage of the juice in the cane. Those who eat jaggery will very soon find out that the "concrete" is just like jaggery, only clean instead of dirty, bright yellow instead of black, and as sweet and pure as honey. The process of manufacture would be very simple; there would be no elaborate arrangement of evaporators and vacuum pans, the "concretor" being a most simple, inexpensive and easily worked contrivance; and the result would be exactly suited to the exigencies of the case. What is wanted is such an improvement on the present barbarous method as shall be sufficiently simple to be practicable by a small band of intelligent men competent to obtain and work the few necessary bits of machinery, and which shall turn out a pure and sweet substitute for *jaggery*, which may be either eaten by the natives or sent to the nearest factory to be converted into refined sugar. This solidified cane juice would produce considerably more refined sugar than the 50 per cent. credited by Mr. Noël-Paton to *jaggery*. The central factory for the district would deal with all the cane within easy reach and would receive from the outlying parts the "concrete" produced in these smaller preparatory factories, which in their turn would be supplied with cane from a considerable circle of their neighbours' cane fields.

If this system were found to be profitable to the workers of the small factories a good demand for cane would spring up, and as the profit would depend in great part on the quality of the cane the growers would be stimulated—as in Formosa—to grow better canes. Thus, the little factories would, on the one hand, conduce to the establishment of large central factories, and, on the other, would stimulate the growth and improvement of the cane.

Mr. Noël-Paton says: "All figures relating to agriculture and commerce in India are, however, subject to violent fluctuations from year to year, according as the rainfall is good or bad." The reply is that such countries as Java, Peru, the Hawaiian Islands, and others, would never furnish us with their present steady supplies of sugar if they did not irrigate their land. On the other hand, Cuba, in a dry season, has a very serious falling off in production, because irrigation is not the rule as in those other great sugar-producing countries. In Europe, too, we had a season quite recently when drought made a difference of 1,200,000 tons of sugar, and caused a rise of nearly 100 per cent. in the world's sugar prices.

This is, however, a side question. The main point and difficulty is that, while the cultivation of the sugar cane has been decreasing in India, the area under other crops has, in many provinces, largely

increased. Mr. Noël-Paton points out "that the high prices of food crops and cotton in recent years has contributed to this substitution; but, after all, sugar is a food crop, and it appears from the statistics that it was regarded as less remunerative than other crops; in other words, that it did not share fully in the appreciation of other produce. The reason for its failure to do so is probably to be found in the cheapness of imported sugar. . . . In other words, the competition of foreign sugar is the one constant and progressive factor that accounts for the general decline in cane cultivation." Here we have the real trouble. How is it to be met? Lord Minto has lately told us in very plain language what Indian industry wants. But we must recollect that India is a good market for one of our most important sugar-producing colonies. If we protect the Indian sugar industry we must, at the same time, give some little preference to our own sugar colonies.

GEORGE MARTINEAU.

THE ACIDITY OF RAW CANE SUGARS.

By WILLIAM E. CROSS, Ph.D.,

Research Chemist, Sugar Experiment Station, Audubon Park, New Orleans, U.S.A.

INTRODUCTION.

The measurement of the alkalinity or acidity of raw sugars does not receive much attention in sugar analysis, and yet this determination is an important one for many reasons; particularly because the reaction of a sugar has an important bearing on its keeping qualities during storage. For beet sugars in the cooler European countries the usual recommendation is that sugars should be made alkaline to prevent deterioration during storage; indeed, it is often stated that slightly alkaline sugars will keep for months without loss if other conditions are favourable. With cane sugars in moist and tropical climates on the other hand the case may well be different, and the fact that no very definite opinion one way or the other is obtainable goes to show that this aspect of the question is well worthy of study. Indeed if a check were kept by our chemists on the degree of acidity as well as the keeping qualities of raw sugars, valuable information might in this way be accumulated.

The measurement of the degree of acidity is however a matter of considerable difficulty, as the end point is often obscured by the colour of the sugar in solution. The question has been for many years the subject of attention here and there, especially in Germany, where sugars must be marked "alkaline" or "not-alkaline" for selling purposes. A method was devised by Prof. Herzfeld which however

only made the claim of distinguishing between acid and alkaline sugars. Later work on this subject showed that the method was more exact than had at first been supposed.

The method I adopted after many experiments was a modification of the Herzfeld method for beet sugars, and the results obtained went to show that in this way the degree of acidity of ordinary raw sugars could be obtained with a fair accuracy. Of course low grade sugars offer more difficulty, owing to the dark colour of their solutions, so that here the results are more approximate.

The method here given is applicable equally to the measurement on the basis of "c.c. acidity" or per cent. lime equivalent, so that it can be used either way, according to preference.

Experimental.—Preparation of Reagents.

Phenolphthalein.—1 part pure phenolphthalein in 30 parts 90 per cent. alcohol.

Neutral Water.—One or two c.c. phenolphthalein to each litre pure, freshly boiled distilled water. Then some of the standard alkali (made as below) added, just sufficient to produce plainly visible pink tinge. This should be prepared some hours before use, and not be kept more than two or three days.

Acid.—(*a*) (*If results are to be reckoned as per cent. CaO*)—

178·5 c.c. $\frac{n}{10}$ sulphuric acid made up to 5 litres $\left(i.e., \frac{n}{280}\right)$.

1 c.c. is equivalent to ·0001g. CaO.

(*If results are to be reckoned as "c.c. alkalinity"*)—

200 c.c. $\frac{n}{10}$ sulphuric acid made up to 5 litres $\left(\frac{n}{250}\right)$.

1 c.c. is equivalent to ·04 c.c. alkalinity.

Alkali.—(*a*) (*Results reckoned as per cent. CaO*)—

178·5 c.c. $\frac{n}{10}$ NaOH to 5 litres. 1 c.c. = ·0001g. CaO.

(*b*) (*Results reckoned as c.c. acidity"*)—

200 c.c. $\frac{n}{10}$ NaOH to 5 litres. 1 c.c. = ·04 c.c. alkali.

The acid should be checked against the alkali.

Titration.

For ordinary raw sugars,* 10 grms. should be dissolved in the neutral water, and the solution made up to 200 c.c. The titration with the alkali is best carried out in a large Erlenmeyer flask over white paper. After a little practice the end point, indicated by a distinct pink tinge of the liquid, is fairly easily distinguishable. In

* The description here given is for acid sugars. Alkaline sugars must of course be titrated against the acid.

an accurate titration the pink colour will disappear where one or two c.c. of the acid are added.

Parallel or triple titrations should be made, and if sufficient practice has enabled one to note the end-point correctly, the values obtained for the same sugar will agree very well.

For darker sugars more water should be used, 10 grms. sugar in 500 c.c. being a convenient dilution. If the sugars are very dark, the accuracy of the determination is only approximate.

For results in terms of per cent. CaO the $\frac{n}{280}$ solutions must be used, when 1 c.c. required = ·001 per cent. CaO equivalent. See example I. For results in terms of "c.c. acidity" the $\frac{n}{250}$ solutions should be used, when the number of c.c. required multiplied by ·04 gives the "c.c. acidity." See example II.

EXAMPLES.

I. *First Sugar, Destrehan Plantation, Louisiana.*

10 grms. dissolved in 200 c.c. neutral water.

Titrated against $\frac{n}{280}$ NaOH.

Titration (a) 14·5 c.c. required.
(b) 15·5 c.c. ,,
(c) 15·0 c.c. ,,
Mean.. .. 15·0 c.c.

Acidity = ·015 per cent. CaO (equivalent), or ·53 c.c. acidity.

II. *Seconds, from "Bessie K." Plantation, Louisiana.* Darker colour.

10 grms. dissolved in 500 c.c. neutral water.

Titrated against $\frac{n}{250}$ NaOH.

Titration (a) 23 c.c. required.
(b) 25 c.c. ,,
Mean.. .. 24 c.c.

Acidity = ·96 c.c. acidity, or ·027 per cent. CaO (equivalent).

III. *Raw Beet Sugar.*

10 grms. dissolved in 200 c.c. neutral water.

The solution had an easily discernible pink tinge, which was removed by 1 c.c. of the $\frac{n}{280}$ acid.

Sugar was *slightly alkaline.*

With the help of this method the acidity of a series of representative sugars was determined. It was found that with the exception of the beet sugar mentioned, all were acid to a greater or less degree.

The results obtained were as follows:—

SUMMARY OF RESULTS.

Sugar.	Per cent. CaO.	C.c. Acidity.
Louisiana Sugars—		
Destrehan Firsts	0·015	0·53
Seconds New Orleans Sugar Exchange*	0·033	1·18
Gramercy Seconds	0·056	2·00
Longview Firsts	0·007	0·25
Gramercy Purged	0·0082	0·29
Uncle Sam Firsts	0·0067	0·28
Belle Helene Firsts	0·0172	0·61
Chatsworth Firsts	0·012	0·48
Experiment Station Firsts	0·026	0·93
Seconds from Sugar Exchange	0·0077	0·27
Bessie K. Seconds*	0·027	0·96
Refined Deteriorated	0·0045	0·16
Seconds New Orleans Sugar Exchange*	0·028	1·00
German Beet	Just alkaline	—
Egyptian Sugar†	0·004	0·14
Cuban Sugars, A*	0·016	0·57
,, B*	0·015	0·53
From San Manuel*	0·025	0·90
Nueva Luisa*	0·012	0·43
Tinguaro*	0·025	0·9
Nueva Paq.*	0·035	1·26
Merciditа*	0·022	0·79
San Antonio*	0·023	0·83
San Ignatio*	0·021	0·75
Chaparra*	0·025	0·9
Conchita*	0·023	0·83

All the sugars were new, except the Egyptian, which dated from the 1903 season.

It is thus seen that the acidity of raw sugars varies within wide limits, and this is, of course, due to the methods of manufacture used. It is entirely within the manufacturer's power to make his sugar more or less acid, so that when it is known what degree of acidity or alkalinity is best to prevent deterioration, sugars can be made accordingly.

Only a large amount of data, however, will determine the relation between acidity and deterioration of cane sugar; and, although the method and results here given only attain a moderate degree of accuracy, yet they may be of reliable service in accumulating these data.

* 500 c.c solvent used. † 1903 Campaign.

SUGAR MACHINERY IN HAWAII.

Among the items of interest that cropped up at the last annual meeting of the Hawaiian Planters' Association, those relating to the sugar machinery section were not the least important.

Reference was made to the recent introduction of conveyors made of canvas, composition rubber, or leather to take the place of the steel slat conveyor. This at first sight seems rather a retrogressive step and might almost be compared with the step of reversion to lathe beds made of *wood*. But, apparently, in Puunene, where these conveyors have been in operation for two crops, they are highly spoken of; the chief points advanced in their favour being that they are cheaper than the steel slat conveyor, are much lighter, require less power to drive them, and they deliver the crushed cane from mill to mill in a much more cleanly manner. Endless belts are preferable if they can be procured, as the one trouble encountered was in connection with the fasteners. One factory manager expressed the opinion that if these belts were studded with copper rivets or sewn with copper or brass wire, and if the edges were over-sewn with wire to strengthen them, these belt conveyors would be capable of carrying megass for at least three or four seasons of 200,000 tons of cane. The initial cost is put at one half that of the steel slat.

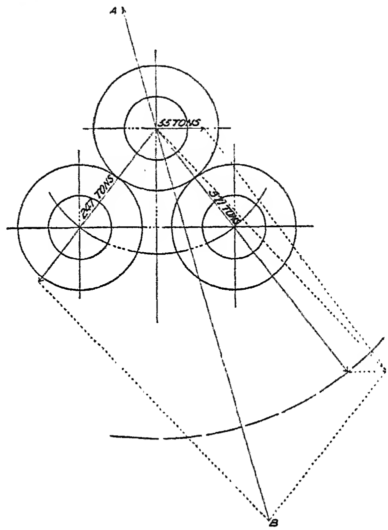
A new patent mill housing at Puunene, which has been running for one season with gratifying results, deserves some notice. The following (extracted from an article on "Sugar Mill Design") will give some idea of the principle on which the new patent is based:—

Let us take the housing or cheeks of the three-roller mill with the pressure on the journals of the top roller, which is the type most used at the present day, and then consider the lines along which the forces will exert themselves; and so demonstrate whether housings as at present designed are as nearly correct as they should be.

If we have one roller above another, so that a perpendicular line passes through the axes of the two rollers, then, leaving out the weight of the rollers, it is evident a weight of 500 tons applied on the top roller will involve for the journals of the bottom roller a resistance likewise of 500 tons. If, however, the top roller rests on a beam supported on two bottom rollers, then each of the latter will have to resist 250 tons. If on the other hand the top roller rests directly on the two bottom ones, and all three are in close contact, then by Rankin's rule for the resolution of a force into two inclined components, we have with 500 tons on the top roller 290 tons on each of the bottom ones. If, however, the bottom rollers are moved eight inches apart, the 500 tons on the top roller would involve 309 tons on each of the bottom rollers. To resist these forces, the Rousselot type of housing seems to be as nearly correct as we can have it made. When a mill is grinding, however, other forces come into action which change

the main line of force of the last cited grouping to such an extent that in place of the king bolts taking all the strain and the top roll, as it were, floating on the bottom ones, we have the top roller brasses wearing rapidly one-sided; and it is not uncommon to have a housing broken by a force directed out of line with the perpendicular king bolts. Suppose it takes 100 h.p. to drive a mill when grinding. This power is applied to the top end of the top roller shaft and is used up in compressing and forcing the cane to travel over the feed roller, in forcing this across the turner bar, and in compressing it still farther and forcing it over the bagasse roller. It does not matter whether the force is transmitted through the pinions or by the surface of the roller. There is no doubt some power used in overcoming the friction of the bearings, but we will not take that in account now as it is only a small percentage of the whole. The cane being forced through the mill, then, offers a resistance to the revolving surface of the top roller equal to 100 h.p. As this resistance takes place on the bottom side of the top roller, the tendency is for this roller to move in a horizontal direction. This is prevented by the mill housing and, if the mill were not firmly bolted to a foundation, it would be turned over. The force necessary to keep this roller in position is equal to 55 tons and is exerted against the front part of the housing in practically a horizontal line. Thus 100 h.p. $\times$ 33,000 lbs. $\div$ 30 (feet per minute, speed of roller surface) $=$ 110,000 lbs. $=$ 55 tons. Again, the pressure applied to the roller is divided unequally between the feed and the bagasse rollers. This is the condition in practice and gives rise to more complications. As the difference in pressure on the bottom rollers varies with the different mill settings, it is impossible to get any figures that will apply to all cases, but suppose, for the sake of discussion, there is 40 per cent. on the feed roller and 60 per cent. on the bagasse roller instead on 50 per cent. on each. Then we have 247 tons on the feed roller and 371 tons on the bagasse roller if we ignore the pressure absorbed by the turner bar. This shows that there is a force equal to one-fifth of the total pressure on the bottom rollers (the difference of resistance of the feed and bagasse rollers) pressing on the top roller towards the front of the housing at an angle of 38°. We have already seen that there is a pressure of 55 tons on the horizontal line in this same direction, and, when these are combined, we find that the line of resistance, under normal conditions, does not produce the perpendicular strain which the present king bolts arrangement is designed to control. The forces required to keep the top roller in its place, under the assumed conditions, are represented in the accompanying sketch, and the resultant of these forces by the line A B. If the pressure on the top roller were applied parallel to this line instead of in a perpendicular line as at present, it would be nearer what practice calls for. This would take away the excessive friction when the top brasses move up and down in the pocket. It

would make a more sensitive mill, especially between the top and bagasse rollers where it is more important. It would also put the total strain on the bolts that hold the top cap and not distribute it over the housing. It would be as near the ideal of a "floating" top roller as could be made.



It is on the above principle that the "Puunene" housing is designed. That its angle is correct would seem to be indicated from the fact that after grinding a crop of over 200,000 tons of cane the tool marks were still plainly visible in the pockets of the top roller brasses of the experimental mill at work at Puunene.

Twelve days' consecutive work grinding hard ratoons on the part of two mill plants with identical settings but No. II. having "Puunene" housings in one mill resulted in the following figures:—

	No. II. Mill (Puunene Housing in Fourth Mill).		No. I. Mill (Old Style Housings throughout
Average extraction for first three sets of rolls..	90·37	..	90·26
Average extraction for the four sets of rolls ..	95·33	..	93·29

Some progress has been made with the proposed beet sugar factory at Kidderminster. Plans for the buildings have been completed and have been exhibited to the public. It is reported that the contract for the machinery has been placed, so we may expect to see Kidderminster one of the first localities in the country to have a beet sugar factory in operation.

OBSERVATIONS ON INVERT SUGAR FORMATION IN A REFINERY.*

By FERD. MORAVEC, Jaroměř, Bohemia.

If the occurrence of invert sugar in the sugar house is a very undesirable phenomenon, it is especially so if, in spite of all endeavours, the cause of its formation cannot be determined.

As is generally known, to work alkaline is a means of preventing the formation of invert sugar. In the raw sugar factory the occurrence of invert sugar can conveniently be suppressed by a higher alkalinity, and if saturating with the addition of lime as ordinarily carried out does not suffice, soda is simply added to the thin-juice and a stable alkalinity thus imparted to the products. Conditions are different in the refinery, where it is not desirable to raise the alkalinity too much; on the one hand because the pure liquors should not be contaminated with foreign substances, and on the other because with increased alkalinity of the liquors other irregularities are capable of occurring, such as bad boiling and the appearance of yellow spots on the finished products, especially when using the old floor method. Even with the greatest care it is not possible to preserve the juices from influences causing the formation of invert sugar.

Such influences causing inversion, it is well known, are exerted by acids and bacteria. Of the latter may be mentioned the dreaded *Leuconostoc mesenterioides*, while many other bacteria contain an enzyme, the name of which—invertase—clearly denotes the power of hydrolyzing sucrose. How many micro-organisms there are which are capable of fermenting sucrose can be realized to some extent from the report by E. O. von Lippmann (*D. Zuckerind.*, *32*, 178), which says: "Sucrose is readily fermented by Lindner's *Sachsia suavevolens*, by Ruhland's *Bacillus spongiosus*, by many of Henneberg's acetic acid bacteria, and by numerous of the micro-organisms isolated by Schöne from diffusion juice. Of the 67 varieties of the latter, 40 make the solution acid, and 10 alkaline; 10 of the first do not produce invert sugar, but five of the last (in spite of the alkaline reaction) form much.

The different bacteria floating in the air are to be met with everywhere, but it is self-evident that they will be the more numerous where the optimum temperature and the suitable nutriment for their growth occur. These bacteria find in a sugar refinery, especially in the floors, the suitable temperature and nutriment in the aqueous sugar solution continuously flowing on the large tray surfaces. From these facts, when invert sugar occurs, in spite of working being carried on throughout cleanly and scientifically, its formation is to be ascribed to bacterial action.

*Abridged translation from the *Zeitsch. Zuckerind. Böhm.*, 1911, *35*, 399.

In a mixed sugar factory, work was carried on for two years in the usual manner without anything abnormal regarding the appearance of invert sugar having been noticed. There were only very sporadic cases in which invert sugar had appeared; and even in these it was not continuous, but only in a single vessel, as probably occurs now and then in every sugar house, from the careless preparation of the clairce or by allowing it to stand in unclean reservoirs or pipes.

The ordinary method of working is as follows:—The affined sugar is dissolved to a density of 28° Bé. at 95° C. in a vessel provided with a stirring apparatus, using water treated with animal charcoal, heated directly in the vessel by a steam injector. To the solution during its preparation so much milk-of-lime is added to give an alkalinity of about 0·01 by volume (phenolphthalein). This solution—first liquor—is filtered over animal charcoal, having then an alkalinity of 0·001 to 0·002 by volume (phenolphthalein), and boiled to massecuite. This is filled into moulds, and after standing is drawn up to the floors, where after the removal of the stopper the syrup runs out, and is collected in tanks.

The refined green syrup—the first runnings from the refined massecuite—has an alkalinity of from 0·0014 to 0·0036 by weight (phenolphthalein). This is diluted with water in a vessel to 30° Bé., and while preparing it so much milk-of-lime is added that an alkalinity of usually 0·0045 by volume (phenolphthalein) is reached. On filtering this solution over the charcoal already used for the filtration of the first liquors, it has an alkalinity of 0·0008 to 0·0028 by volume (phenolphthalein). From these two liquors *pilé* massecuite is generally boiled.

The first portion of the runnings from the *pilé* massecuite has an alkalinity of 0·002 to 0·004 by weight (phenolphthalein), and this, like the first green syrup, is diluted to 30° Bé. at 95° C., and boiled, sufficient lime being added to give the solution, after mechanical filtration through a Puvrez filter, an alkalinity of 0·005 by volume (phenolphthalein). This sugar solution is boiled to second quality sugar massecuite.

The first portion of the runnings from this massecuite—third quality green syrup (*Lompen grün syrup*)—has an alkalinity average of 0·0037 by weight (phenolphthalein), and generally shows traces of invert sugar. This green syrup is employed for the mixing of the raw sugar for affination, and partly also for washing in affination.

A portion of the affination runnings are taken back to the raw sugar factory for raw sugar boiling, being first of all heated with lime and water till invert sugar can be no longer detected. The lime is so regulated that this solution—third liquor—after filtration through a corrugated sheet-metal (*Wellblech*) filter shows an alkalinity approximating to that of the thick juice. This third liquor is treated with sulphurous acid in the same way as the thick-juice, and the alkalinity

stopped at about 0·003 by volume (phenolphthalein). This solution is mixed with thick-juice, and generally boiled to raw sugar.

During the third year some improvements were introduced into both factory and refinery. In the factory the Stutzer-Funk kieselguhr method (this *Jl.*, 1909, 47) was installed. In principle this consists in adding to the juice heated to 95° C. 0·07 per cent., calculated on the roots, of kieselguhr, mixing for 10 minutes at the same temperature, then adding 1·25 per cent. of lime in the form of milk at 20° Bé., and again mixing for five minutes. After this the juice is saturated with carbonic acid to an alkalinity of 0·10 by volume (phenolphthalein) and filtered through the scum presses.

In the refinery, hydrosulphite in powder form, marked "$\frac{\text{Z}}{\text{BASF}}$ the most active, non-inverting," was employed for the decolorization of the massecuite. Of this there was drawn into the vacuum for a strike of refined massecuite, 0·0025 per cent.; for a strike of *pilé* massecuite, 0·0033 per cent.; and for a strike of third quality sugar massecuite, 0·0055 per cent. In other ways the refinery liquors were treated as in previous years, and reached the evaporators quite sound, pure, and free from invert sugar.

Now, however, in this third year, invert sugar showed itself in the refined green syrup, and increased in the floors to a considerable extent. In consequence of this, hydrosulphite was no longer employed, the invert sugar formation being ascribed to this preparation. But since hydrosulphite had elsewhere given good results, and had been used and recommended by other factories, its use was not definitely abandoned, but experiments were carried out in the laboratory.

In two beakers equal amounts of pure refinery liquor, free from invert sugar, and previously filtered over charcoal, were heated to 75°C. One was treated with 0·0025 per cent. of hydrosulphite, and both samples, the one with and the other without hydrosulphite, maintained at 75°C. for two hours. On subsequently testing for invert sugar no difference between the two could be indicated.

As a matter of fact, the observed invert sugar did not originate from the action of the hydrosulphite, since it occurred in the centrifugal syrups for a long time after hydrosulphite had been no longer employed.

Although after this the greatest care and exactness was used in the preparation of the liquors, and in the cleaning of the floor trays, invert sugar still appeared in the refinery syrups.

By experiments with laboratory syrups it was established that the amount of invert sugar in the syrups which were strongly alkaline was appreciably less than in the syrups which showed only a slight alkalinity. With an alkalinity of over 0·01 by weight (phenolphthalein), the refinery syrups contained less invert sugar than when its alkalinity fell below this amount.

It may be mentioned here that the traces of invert sugar, which generally occurred in amounts incapable of being determined quantitatively, were estimated by comparing the precipitates thrown down under exactly the same conditions and collected on small filters of equal size.

On the ground of the knowledge that the more alkaline liquors were less attacked, measures were taken to increase the alkalinity. Originally these had been brought with lime to about 0·01 by volume (phenolphthalein), but now by the addition of more milk-of-lime this was raised to 0·018 by volume (phenolphthalein). On filtration, the alkalinity of these liquors was at most 0·0017 by volume (phenolphthalein), so that apparently a large quantity of the added lime had been absorbed by the charcoal. So as to give a higher stable alkalinity to the filtered liquors, soda and milk-of-lime in the proportions of 1 : 1 were added in such amount that the alkalinity after filtration remained fixed in the neighbourhood of 0·0056 by volume (phenolphthalein) in the case of new, and 0·007 by volume (phenolphthalein) with already used char.

It was noteworthy that then the filtered liquors showed no reaction for invert sugar. Frequently the same products before boiling, and also the finished strike, were examined with a similar result.

At the same time samples were taken from several moulds immediately after filling, and again after eight hours, in both of which cases the invert sugar reaction was about equal. Hence in this department the invert sugar had not increased. However, as soon as these moulds had been unstoppered, and the green syrup had passed the trays, the reaction was considerably more marked.

At this time an article by Gredinger, then manager in Müglitz, was published in the *Techn. Rundschau a. d. Gebeite der Zuckerind. u. Landw.*, 1906, in which reference was made to a case of invert sugar formation caused by filteration through charcoal. Acting on this notice, similar experiments were carried out, but it was found that our charcoal had no influence on the juice in this direction.

There was nothing left to us to do than always to keep the juices and syrups strongly alkaline, and to continuously remove the invert sugar from the liquors by boiling with lime.

It must be repeated that it is striking that the amount of invert sugar in the syrups increased on passing the tables. This phenomenon had first been noticed with the refined green syrups, but afterwards with all the other runnings that passed the floor trays.

In order to find out to what extent the invert sugar would be increased, equal amounts of the different runnings were allowed to stand on large porcelain dishes in the laboratory, frequently mixed, and each day examined for invert sugar. It was found that no invert sugar formed in the dishes, and that each running which originally already contained invert sugar had the same amount after ten days.

Since there is a large difference between the temperature of the floors and that of the laboratory, *viz.*, 32 to 35° C. against 18 to 22° C., it was concluded that the formation of invert sugar had been favoured by the higher temperature of the floors.

Since in this campaign raw sugar produced by the Stutzer-Funk method had only been used, it was thought that the liquors thus produced might show a greater inclination to invert sugar formation. That this was not the case was shown by the fact that after the conclusion of the campaign other raw sugars were refined, in spite of which the phenomena indicated occurred in the same degree.

The observations made lead to the supposition that the invert sugar found in the refinery liquors had been caused by the action of micro-organisms of the air at favourable temperatures. The traces of invert sugar present in the massecuite had become concentrated in the run-out syrups and further increased when the syrups flowed over the mould trays at the prevailing temperature, which had been favourable for the development of the bacteria.

THE BACTERIAL DETERIORATION OF SUGARS.

By Wm. L. Owen, B.S.,

Bacteriologist of the Agricultural Experiment Station of the Louisiana State University.

(Continued from page 269.)

Part II.

Results of Experiments upon the Deterioration of Sugars.

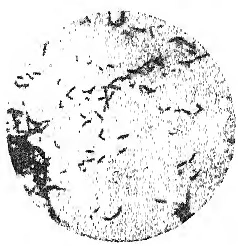
Having isolated the species of bacteria that were found to occur most extensively in sugars, and which were suspected of being the causative agents in the deterioration that the products from which they were isolated were undergoing, it was the next step in the investigation to determine the relative powers of deterioration of the various species. It was also of great importance to ascertain the relative activities of each species on different classes of sugars in order that the factors influencing this action might be discovered. The control work on the sugar samples had shown the range of bacterial association to be quite extensive, since almost all of the samples on hand were falling in polarization from month to month, and since the characteristic organisms were found in nearly all of them. As the samples had been collected from all parts of the world, it indicated that this type of organism is not confined to any particular locality, but is prevalent wherever sugar is manufactured to any

extent. It is obvious therefore that the problem of deterioration of sugars by bacteria is almost world-wide and by no means a local condition. The monthly analyses which were made on the samples together with the careful records of the bacterial flora of the products furnished excellent data upon the relation between the deterioration of a sugar and the micro-organisms occuring therein. Such records were of interest furthermore because the variety of samples at our disposal were representative of all the various grades of sugars and methods of manufacture, and thus afforded ample opportunity for correlative studies on the influence of these factors upon the keeping qualities of a sugar. But it was necessary to supplement these studies of sugars under natural conditions of bacterial contamination with others designed to show what pure cultures of the various species would bring about when introduced into sterilized sugars. It was only in this way that the deteriorative action of each species could be definitely ascertained since the deterioration of a sugar in which many species occurred would naturally be attributed to their collective activities. It would be impossible under such conditions to determine the relative parts played by the various species in bringing about the deterioration of a sugar. If there existed a certain interdependence between the species in their activities the use of pure cultures in inoculating sterile sugar would readily demonstrate it. The necessity of sterilizing the sugars used in these experiments confronted us with a somewhat difficult operation, since this material is quite readily changed by the temperature necessary for a complete sterilization, as, owing to its physical condition, it has to be heated for a considerable length of time in order that the heat may penetrate through the mass. In addition to these conditions, which render the sterilization of sugar a difficult procedure, the extraordinary viability of the spores of the organisms constituting the bacterial flora of sugars makes it next to impossible to practice the single sterilization method without subjecting the material to temperatures that would cause both physical and chemical changes therein. It was necessary therefore to adopt the intermittent sterilization method, which was used with a fair degree of success throughout our experiments. The sugars were first placed in litre Erlenmeyer flasks, usually about 500 grms. to the flask, and after plugging with cotton they were placed in the autoclave and subjected to a temperature of 220° F. for thirty minutes on each of three consecutive days. At the end of this period the success of the sterilization was determined by inoculating culture tubes of nutrient sucrose solution with small quantities of sugar from the flasks of sterilized sugars. Where any development took place in the inoculated tubes the flask of sugar from which the tube was inoculated was discarded and only those were used in the experiments that gave no growth when transferred to culture media. The sterile sugar was next inoculated and placed in the incubator at a temperature of

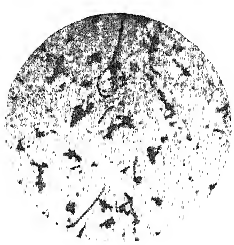
37·5° C., where it was kept for a period of thirty days usually before being analysed. In every case uninoculated control flasks were kept under conditions identical with those of the inoculated as a check on the results. The inoculation of sugars gave some trouble, as it was very difficult to distribute the inoculating material uniformly throughout the sugar by the ordinary method of using agar cultures. A uniform distribution of the inoculating material is particularly to be desired in this case, as the sugar crystals do not offer a continuous surface for the development of bacteria and the extension of the inoculated portion so that the spread of the organisms throughout the mass is somewhat slow. On the other hand, there is the objection to the use of liquid cultures for inoculating purposes on account of increasing the moisture content of a sugar. As this factor is often a limiting one in the deterioration of sugars, it is obviously a great disadvantage to change the moisture content in our experiments since the results from such inoculations might not be applicable to the particular sugar with its original moisture content. In order to obviate the necessity of using culture solutions in our inoculations, several methods were tried with only partial success. One of these was the use of ordinary river sand, which was first treated with hydrochloric acid to remove all of the bases so that the degree of acidity produced in the sugars would not be changed. After the sand had been thus freed of its bases, and then washed thoroughly, the culture to be used was transferred from the culture flask and mixed thoroughly with it. The sand mixture was then transferred to the flask containing the sterile sugar, where it was thoroughly mixed by shaking. The chief objection to this method was that the sand would often introduce an error in the analytical work, and even where this did not occur there still remained the objection that the addition of the sand would affect the physical condition of the sugar. It is not very probable that the presence of the small amount of sand used in the inoculations would affect the bacterial action in a sugar. At the same time it is conceivable that where a grain of sand interrupts the sugar crystals, or their surrounding films, that it might act as a barrier, or, at least, impede the progress of the organisms between the crystals and in this way retard the distribution of the inoculation throughout the mass of sugar.

Another method of inoculation that suggested itself was the use of dried agar cultures, but to this there was the same objection as to the sand, since the material thus introduced within a sugar would constitute a likely source of error in analysis and might also affect the progress of the organisms between the crystals. In addition to these, however, are the further objections of the possibility of inducing a certain degree of attenuation in the cultures by drying, and the disadvantage of adding traces of nutrient material contained in the dried culture. This method was used to a limited extent, and although

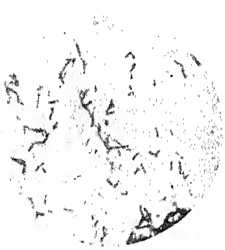
1. Bac. vulgatus A.



2. Bac. vulgatus B.

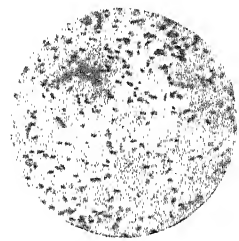


3. Bac. vulgatus C.

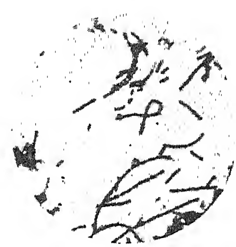


4. Bac. vulgatus D.

5. Bac. mes. fuscus.



6. Bac. mes. fuscus A.



7. Bac. gummosus.

8. Bac. liodermus.

SOME OF THE BACTERIA CAUSING DETERIORATION IN SUGARS.

it was found that the drying of the cultures did not seem to affect the virility of the micro-organisms, yet the method was discarded because of the possibility of altering the natural nutrient value of the sugar as a culture medium by the addition of the dried culture. Although only traces of nutrient elements might be added to the sugar by this method, yet it might affect the action of the bacteria, particularly because of the small amount of such elements that it naturally contains. One of the methods that was used somewhat extensively in the inoculation of sugars and which proved fairly satisfactory, and without the disadvantages of the methods so far described, was that of first inoculating small quantities of sterile sugar and after the organisms had developed therein this was transferred to large quantities of the same sugar. The sugar was sterilized in the usual way in 500 c.c. flasks and also in smaller quantities in test tubes. After sterilization the tubes were inoculated by means of a platinum loop upon which small portions of agar culture were transferred from the stock culture. The inoculated tubes were then incubated at 37·5° C. for several days, at the end of which time the success of the inoculation was first determined by transferring small portions of the sugar to culture media before the contents of the tubes were transferred to the larger flasks. Where the transfers from the tubes to the culture medium showed that the inoculations had been effective, the flasks were inoculated by pouring out the contents of the tubes and mixing them with that of the larger flasks. In some cases bacterial counts were made of the tubes before using, but in most cases the development from the sugar transferred from the tubes to the culture medium was made the criterion for the transfer to the large flasks. The principal objection to this method was that in many cases the sugar would become so tightly packed in the tubes during sterilization that it would be almost impossible to remove it. This was particularly true of the lower grade sugars which exhibit a marked tendency to cake when heated.

The use of culture solutions has much to recommend it as a means of inoculating sugars. It is much easier to secure a uniform inoculation in this way than by the dry method, and it is also free from the objection that applies to the addition of any foreign substance to the sugar as in the case of such methods. By using the same quantity of solution in the uninoculated control flask as is used in the inoculations, the moisture content of the flasks is equalized and no corrections are rendered necessary in the analysis. As most of the analyses in these experiments were made with corrections for moisture, the addition of moisture in inoculation offered no difficulty in the analytical work. The objection still remains, however, that the addition of moisture renders a sugar more susceptible towards the particular action that we wish to induce and to that extent has the disadvantage of changing the natural relation between the sugar and its tendency towards deterioration. If solutions are used in

inoculations it is necessary, therefore, to use as small quantities as possible so that the moisture content of the sugar may not be materially increased. In order to distribute the minimum quantity of solution through a maximum amount of sugar, advantage was taken of the principle of atomization and a device was designed having this as a basis. The apparatus consisted of three parts, viz.: (1) An air pump and an air cylinder combined in which an air pressure of several kilos. could be maintained, (2) an ordinary double neck bottle in which sulphuric acid is kept for the sterilization of the air supply, and (3) an atomizer for the atomization of the culture solution. The atomizing flasks were detachable from the other parts of the apparatus so that cultures to be used might be generated in these flasks, which could be attached just as they were needed. The method used was as follows: A nutrient medium consisting of distilled water to which 0·01 per cent. of peptone was added was used for the propagation of the culture. About 10 c.c. of this medium was placed in each of the atomizing flasks and sterilized in an Arnold sterilizer. After sterilization the flasks were inoculated with the cultures to be used by transferring with the platinum wire small portions of the agar culture to the flasks. In order to thoroughly mix the inoculating material with the liquid in the flasks the platinum wire containing the agar culture was introduced into the inlet tube as far as possible and the liquid then brought in contact with it by tilting the flask. After inoculation, the flasks were placed in an incubator and kept at 37·5° C. for several days until the cultures had reached a high state of development, as indicated by the cloudiness of the liquid in the flasks, when they were then removed and used in inoculating sugars. The flasks were fitted with very closely fitting ground glass tops, which, when greased, would prevent any contamination of the inoculating medium. As the inlet and outlet tubes were always plugged with cotton during the sterilization and incubation periods, there was little danger of contamination from that source. In every series of flasks used in these inoculating experiments there was one left uninoculated as a control, which served to test the efficacy of the method. There were very few cases in which the control flask showed any contamination, and, in fact, the percentage of such cases was not greater than would occur in ordinary routine work where very resistent organisms are used and sterilization methods more apt to be ineffective. But it is barely possible, of course, that there might have been a certain amount of contamination within the control flask without it being noticeable owing to the small amount of nutrient elements contained in the inoculating medium. Conditions offered by this medium would not likely promote a very rapid or vigorous growth of the majority of bacterial species, so that it is perfectly conceivable that a few bacteria having gained access to the control flask would likely develop so slowly that their presence therein might never be suspected.

In exactly the same way we might introduce in our inoculation sugars a few cells of a different species of bacteria from that of our culture without affecting in the least the ultimate purity of the culture that we used. It is only because sugars do not offer conditions favourable for the development of micro-organisms in general that the inoculating apparatus used in these experiments is permissible on a strictly scientific basis. As the flasks have to be connected to the other part of the apparatus by rubber tubing, which is not at all readily sterilized, and as the passage of the air through sulphuric acid may not always be relied upon to sterilize the air, in most cases it can not be considered as reliable as sterilization by heat. The apparatus is not, therefore, one that could be considered of absolute accuracy in so far as the atomization of a pure culture is the purpose of its use, but under the conditions of the experiment and the nature of the material upon which it was intended to be used, it was to be regarded as a thoroughly reliable method.

The Results of Experiments on the Deterioration of Sugar.

The sugar that was used in our inoculation experiments was the large crystal type manufactured in Peru. On account of the size of the crystals, it was much easier to sterilize it without caking during the heating process than would have been the case with a smaller crystal sugar. After inoculation the sugar was placed in an incubator, where it was kept at a temperature of 37·5° C. for a month, when it was again analysed. The results obtained show that with almost all the organisms the single polarization indicated a decrease in sucrose and the Clerget shows a corresponding increase. As the reducing sugar had almost invariably increased, it indicated that some deterioration must have taken place, and that the Clerget determination had most likely been subjected to an error. In our first experiment upon sugars we discarded all results that showed this peculiarity, as we attributed such an increase of the sucrose by Clerget to the lack of uniform sampling or some error in manipulation. Results of this kind, however, were obtained so consistently in our subsequent work that we were compelled to regard the phenomenon as a constant factor in the bacterial deterioration of sugars. It required some time for us to discover just what caused this phenomenon, and it is to Assistant-Chemist W. G. Taggart, who was in charge of the analytical work in these investigations, that the credit for the explanation of this is due. Mr. Taggart attributed this increase in sucrose Clerget in the analysis of the sugar to the presence of levan. He reasoned that this levo-rotary gum, which tends to decrease the single polarization by its optical activity would have a tendency to increase the Clerget determination through its hydrolysis into levulose during the inversion. In order to test the point still further, however,

he compared the analyses of these sugars by the ordinary Clerget method with the analyses made where invertase was used for the inversion of the sugars. It was found that invertase did not act upon the levan. He reasoned that this method would eliminate any error that was due to the hydrolysis of levan into levulose by the use of acid.

The affect of gum on sucrose Clerget, as shown from comparison of sucrose Clerget with true sucrose determined by Hudson's invertase method (this *Journal*, 1910, 192):

			Single Polarization.	Sucrose by Clerget.	True Sucrose by Invertase Method.
Sample	No. I.	Refined sugar.. ..	99·98 ..	99·99 ..	99·98
,,	No. II.	Inoculated solution containing gum	0·00 ..	0·8 ..	0·17
,,	No. III.	Peruvian crystals ..	91·20 ..	95·0 ..	91·4
,,	No. IV.	From Gramercy ..	87·0 ..	89·82 ..	87·6

The results of these experiments as given in the foregoing table conclusively show that the high Clerget results were to be attributed to the presence of levan in the sugars. The difference in the result by the two methods was convincing of the presence of levan in the sugars, and it showed that this difficulty was quite readily overcome by the substitution of the invertase for the acid method of inversion. The invertase used in this experiment was prepared from yeast by the method recommended by C. S. Hudson (*loc. cit.*). Further proof of the presence of levan in those sugars whose analysis indicated that it had been formed therein is lacking owing to inability to separate this material from such products. In many cases we were able to obtain by alcoholic precipitation certain bodies that resembled the gum in their optical activity, but all efforts to purify it to a point where its identification could be proved were fruitless. In those sugars where the Clerget always indicated the presence of levan there were so many impurities precipitated by alcohol that the levan could not be identified. It was found, however, that even where levan was added to this class of sugar it could not be recovered from them in such a state of purity as would permit of its identification. Where it was added to higher grades of sugar it could be separated, but in every case where it was tried upon the sugar suspected of containing levan the effort always met with failure. This experiment conclusively proves that negative results in the isolation of levan from sugars cannot be taken as an indication of its absence in such products. In the light of these results, and in view of the preponderance of evidence indicating the formation of levan in sugars by the organisms causing their deterioration, it seems certain that the presence of this substance is responsible for the error in the Clerget method of determining sucrose. As the organisms constituting the bacterial flora of sugars have been found to develop gum in all cases where they attack sucrose, and as these species have

been found in all of the sugars undergoing deterioration, it seems certain that the formation of levan was responsible for the phenomenon. The correction of this error by the use of invertase, which has no action upon levan, is further proof of the presence of this gum in those sugars where the Clerget was so much higher than the single polarization. Mr. Taggart* has calculated the influence of levan upon both the single polarization and the Clerget method of analysis, and has found that one per cent. of levan will decrease the single polarization and increase the Clerget.

ANALYSES OF SUGAR SAMPLES, SHOWING DETERIORATION IN STORAGE.

Sample No.	Date of Analysis.	Clerget (Moisture-free Basis).	Single Polarization (Moisture-free Basis).	Reducing Sugars.	Moisture.
Sugar No. 31—	August, 1909	——	96·72	2·47	·80
	September, 1909	96·71	96·42	2·26	·95
	February, 1911	90·19	86·2	2·22	1·05
Sugar No. 32—	August	——	95·9	3·27	·90
	September	95·79	95·49	3·83	1·35
	February	89·74	85·15	3·22	1·36
Sugar No. 33—	August	——	79·48	10·0	6·20
	September	82·15	78·42	10·2	6·40
Sugar No. 34—	August, 1909	——	83·66	11·76	4·50
	September, 1909	84·14	81·32	9·52	6·05
Sugar No. 39—	August, 1909	——	90·45	——	5·25
	September, 1909	89·84	90·14	——	5·70
	February, 1910	93·99	89·34	1·72	5·53
Sugar No. 40—	August	——	92·35	——	3·30
	September	90·99	91·52	——	3·85
	February	92·65	91·88	2·08	4·01
Sugar No. 41—	August	——	97·68	——	·90
	September	97·56	97·37	——	1·00
Sugar No. 43—	August, 1909	——	92·75	——	3·50
	September, 1909	91·86	90·51	——	6·20
Sugar No. 46—	August, 1909	——	98·08	——	·90
	September, 1909	97·76	98·02	——	1·15
Sugar No. 47—	August, 1909	——	97·94	——	·65
	September, 1909	98·22	98·03	——	·85
Sugar No. 50—	August, 1909	——	85·59	——	4·20
	September, 1909	86·72	85·64	——	4·25
	February, 1910	85·59	84·84	7·14	4·41

In the above table will be seen the results of deterioration of sugars under natural conditions. These results are from the analyses of the sugar samples that were kept in the laboratory. It will be noted that the results from this work were similar to those under conditions of pure culture inoculation, which tends to confirm

* Mr. Taggart has now in the course of preparation a paper on the influence of levan upon the analyses of sugars.

the theory of the formation of levan. It will be noted that in almost every case the single polarization showed a decrease in sucrose and the Clerget a corresponding increase. Owing to the many irregularities in the analyses of sugars occasioned by the presence of levan formed in the deterioration, this work was discontinued and experiments with sugar solutions taken up. It was thought that in this way conclusions in the matter would be more readily reached.

TESTING SUGAR BEET SEED.

Abridged from an article by R. L. Adams in the *American Sugar Industry.*

Of all the various factors under the control of man in growing sugar beets, the securing of as nearly perfect a stand as possible is first in importance, under proper environment of soil and climate. Unbroken rows of young seedlings permit proper thinning, correct spacing, selection of thrifty, healthy individuals, and insure as many beets to the acre as the soil can support. Thus from the very start a sufficient number of desirable plants is assured.

To secure a perfect stand, selection of good seed is the most important factor. While proper preparation of the soil and favourable weather at time of seeding are necessary requirements, the vitality of the seed far surpasses these in importance. The seed is the hinge upon which the future crop turns. Without good seed to start with a perfect stand is impossible, under usual field methods, no matter how well the soil is prepared or how genially the sun may shine.

The seed factories have long recognized the importance of good seed. Long before the present day advocates of proper seed selection had forged to the front, this matter had received attention from the purchasers of beet seed. The factory authorities recognized, and still recognize, the necessity of maintaining a high standard in the seed, for, with a highly bred plant like the sugar beet, the characteristics are not firmly established and tend to vary with unusual or different conditions of environment. Therefore, in order to insure continuation of the desired qualities, careful selection must be followed. The seed breeder and the seed purchaser are both intimately concerned.

In addition to this determination of the inherent characteristics of a seed, is a second, distinct test—the determination of the vitality of the seed. The first test deals more with the selection of the brands to grow, the second undertakes to determine the strength and purity value of the selected seed.

The test for strength and purity should be made with every lot of seed purchased. No elaborate apparatus is required and any intelligent man can run the tests.

The laboratory testing of beet seed—tests for strength and purity—cover two distinct lines. The test for strength determines the vitality of the seed, as measured by its capacity to germinate. The purity test investigates the character and amount of foreign matter present, as weed seeds, sticks, stones, insects and the like.

The most accurate and most scientific way to secure samples for testing the germinating quality is to use a sample tube and extract a small portion from several sacks of seed, taking from top, centre, and bottom of each bag. These several portions then are mixed together and a small final sample taken from this mixture. But if the number of sacks is small or there are conditions such that this method of sampling is not feasible, samples for germinating tests can be secured from the sacks taken for weed examination. For out of each one hundred or two hundred sacks at least two should be selected, the seed weighed, and then gone over carefully for the purity test. By taking handfuls of seed from different parts of these sacks while the examination is going on, fairly accurate samples will be secured.

From the final sample seed lots of one hundred seed balls each are counted out, three or more lots being taken from each kind of seed. These lots are then germinated all at one time and the averages taken. This cuts down the chances of error.

These lots of seed are put in receptacles suitable for sprouting. Note is taken of the time required for the sprouts to start, and the total number which appears at the end of four, seven and fourteen days. The test is concluded at the end of two weeks.

The actual beet seed is, of course, hidden away in the corky folds of the seed ball. By extracting several of these seeds with the point of a penknife, and examining them for brightness of colour and degree of plumpness, a fair idea of their germinating ability can be gained, as well as an estimate of poor seed and empty capsules present. In counting out the seed all balls should be taken as they come, both large and small. The buyer pays for all in the sack, and poor seed as well as good, for fairness, should be included in the trial, no attempt being made to practice selection of either kind.

Of a large number of sprouting methods tried, I have found the best simple apparatus to consist of a granite-ware pie plate, two heavy filter or blotting papers cut to fit the plate, and a plate of glass to cover. The papers are thoroughly soaked at the beginning of the test and all excess water allowed to drain off. One sheet is then placed in the plate, the seed sprinkled upon it, the second sheet of paper put above, and the whole covered with the glass. Once the seed is soaked up it needs no water as the energy stored in the seed will continue growth for at least six days. The amount of water retained in the paper will usually prove sufficient for the test. Should the papers begin to dry out, however, water can be sprinkled over

them at the end of either the four or seven-day period. All plates, though, should be treated to the same amount of water. The object of the test is merely to determine the starting power of the seed.

By the end of four days some germination should take place. By the conclusion of the seven days numerous sprouts will be present. The division of the sprouted and unsprouted seed is then necessary. By means of a pair of tweezers the sprouts can be removed, being counted as they are taken off, and the ball placed on a portion of the blotting paper marked "O.K.," or some such symbol to distinguish the sprouted from the unsprouted seed. The record will show the germination and the number of sprouts for the period.

At the end of fourteen days the seed is again examined. Such seedlings as have appeared in the interval are counted and added to the seven-day results, and the increase in germinated seed balls is likewise added. This figure gives the total germination.

In Germany the Magdeburg rules require:—

1. There must be 50,000 seeds per kilogram of seed (practically 2·2 lbs.).
2. There must be 150 germs (sprouts) for large seed and 130 for small seed from 100 seed balls.
3. From 100 seed balls not more than 20 large or 30 small seed balls must fail to germinate.
4. Fifteen per cent. of moisture in the seed is excellent, 17 per cent. is allowable.
5. Large seed is that of less than 45 seed balls per grm. (practically $\frac{1}{28}$th of an ounce). Small seed is that which runs over 45 seed balls to the grm.
6. Not over 3 per cent. of impurities is allowable.

The question of temperature influences the germination of beet seed. German authorities recommend maintaining a temperature of 30° (77° F.) for six hours daily, and 20° (68° F.) for the remaining eight hours. While these rules are important in scientific work, they involve the purchase and use of an incubator. Such a course of procedure, involving an outlay for the original equipment and subsequent care and attention, is really unnecessary for running factory tests. With a room kept at ordinary, comfortable, living temperature day and night the seed will germinate sufficiently to show its vitality. It should be borne in mind that the final test is to take place in the soil, and seed which requires pampering to germinate in the tests, is certainly not the most suitable for ordinary field conditions. While absolute control of environment is necessary for procuring scientific results, the benefits of such are greatly increased, if merely a fair index of the seed's power to germinate is all that is desired. Usually, the test must be made on receipt of shipment, or at least several weeks before planting time. As conditions then are apt to be different than at sowing time, some precautions may be needed to

guard against excessive heat or cold. The best general guide which can be given is to secure conditions as nearly like those at planting time as possible. It is always well to duplicate early tests at planting time. Then when future tests are made early, available data will be at hand for determining and allowing for the different conditions in the preliminary tests.

The number of seed balls to the ounce varies greatly. In a lot of six samples they varied from 953 to 1503 seed balls per ounce. From that it is evident that if each of these two extremes sprout an average of two seedlings to the ball, only 63 per cent. of the second must germinate to equal the number of seedlings secured from a 100 per cent. germination of the first. The number of seedlings procured per pound of seed in the field is what counts. Small seed with a relatively low rate of germination may prove to be cheaper than large seed balls with a high rate of germination. This fact is taken into account by the Germans, as shown in the list of Magdeburg rules. For practical purposes, however, the determination of seedlings per ounce will cover all cases.

Intimately connected with the above test is one for impurities to which allusion has already been made.

Two sacks are selected from each hundred in the shipment. The contents of these are then run through a sieve containing $\frac{1}{8}$ inch holes. The substances passing through this sieve are then passed through another of $\frac{1}{16}$ inch holes. These screenings separate the different grades. The amount of acceptable seed will not pass through either sieve, in other words it is over $\frac{1}{8}$ inch in diameter. The small seed is that which passes through both sieves. At each operation the seed in the sieve after being sifted is picked over by hand and all impurities removed—weeds, sticks, flint, pebbles, dead insects and the like. One will be surprised at the collection of stuff which finds its way into the seed.

The best screens are made of metal bottoms with wooden sides, about 2 feet across and 5 or 6 inches high, round in shape. The holes, of course, are round and punched in the metal bottoms.

Should the small seed balls contain plump, well-rounded seed, they will be acceptable, but as a rule the stuff passing an $\frac{1}{8}$ inch hole consists of immature, worthless flower heads, and may be left out of consideration.

The determination of the weed seed is important. In most beet seed there usually will be a small quantity. Some grains and peas may be found and such other crops as usually enter into rotation with the growing of beet seed in the country where it is produced. The worst pests are black bind weed (*Polygonum convolvulus*), wild morning glory (*Convolvulus arvenis*), and radish or charlock (*Raphanus raphanistrum*). Others of less importance, as smartweed, thistle, goosegrass, pigweed, and wild lettuce, also occur at times. The

presence of the first three is to be condemned. This is particularly true of the wild morning glory, a perennial trailing vine which has secured a serious foothold in many agricultural districts. While the beet seed is by no means entirely responsible for the spread of this pest, there is enough present now without adding to it from any source. Out of fairness to the seed growers I should add that the beet seed as a rule comes clean of most things. Only occasionally is there an exception, but it is the exception that must be guarded against.

ANALYSES OF CANE SUGARS OF DIFFERENT QUALITY AND OF DIFFERENT SOURCES.

By H. Pellet.

To the kindness of Mr. C. A. Browne, Ph.D., chemist to the New York Sugar Trade Laboratory, we owe a series of 16 samples of cane sugars of different qualities and of different sources, for which we thank him sincerely. These samples we have analysed by different methods:—

(1) The first analysis was carried out by the ordinary method, *i.e.*, by determining the polarization after clarifying by the amount of basic lead acetate strictly necessary to effect clarification, but *not using excess*. The reducing sugars were estimated in the liquid by means of direct decolorization (Violette's method); while the ash was determined by the sulphuric method, one-tenth being deducted. The water was estimated at 103 to 105° C., and the undetermined organic matters taken by difference. As to the rendement, this was calculated by the coefficients 4 and 2, the former being applied to the ash and the latter to the reducing sugars. In a word, the ash was multiplied by 4, the reducing sugars by 2, and the result added together. This total, on being subtracted from the polarization, gave the refining (industrial) rendement.

(2.) The second analysis was made by determining the reducing sugars by precipitation, and weighing the copper in the form of black, cupric oxide. The direct polarization was found with basic lead acetate, and the sugar was determined by Clerget.

(3.) For the third analysis we took: (*a*) the sugar by Clerget; (*b*) the reducing sugars directly; and (*c*) the soluble ash.

From the results it will be seen that the figure for the sugar by Clerget is very close to that for the sugar direct, as will especially be seen from analyses Nos. 1, 2, 3, 4, 5, 7 and 8. In No. 6 the sugar by Clerget is slightly below the direct polarization, and this will be explained by what we have to say later on.

In the case of the other samples, the differences between the two polarizations and the reducing sugars determined directly are as follows:—

No. of Sample.	Difference between the two Polarizations.	Direct Reducing Sugars.
9	1·00	2·80
10	0·60	2·30
11	0·40	2·66
12	1·70	4·03
13	1·90	6·20
14	1·30	4·66
15	1·60	6·25
16	1·60	7·45

It is seen that the difference between the sugar by Clerget and the polarization rises with the amount of reducing sugars, but that this increase is not absolutely proportional. This is due to the composition of the reducing sugars being variable in dextrose and levulose, which has already been pointed out several times. This is why it is possible to have the sugar by Clerget less than the direct polarization, if the reducing sugars contain a large proportion of dextrose, as when the cane is very ripe.

As to the reducing sugars, they vary according to whether the sample is treated by basic lead acetate or not:—

No. of Sample.	With Lead.	Without Lead.	Difference.	Soluble Ash.
1	0·22	0·22	0·00	0·45
2	0·72	0·80	0·08	0·37
3	0·90	1·10	0·20	0·57
4	0·55	0·60	0·05	0·52
5	0·70	0·65	—	0·87
6	1·73	1·69	—	0·62
7	1·97	1·87	—	1·53
8	0·77	0·80	0·03	2·32
9	2·52	2·80	0·28	1·73
10	1·98	2·30	0·32	3·45
11	2·16	2·66	0·50	2·72
12	3·67	4·03	0·36	3·27
13	5·73	6·20	0·47	2·83
14	4·61	4·66	0·05	1·35
15	6·30	6·28	—	1·32
16	7·40	7·45	0·05	1·77

Thus it is seen that the difference between the reducing sugars as determined: (1) with lead, and (2) without lead increases with the amount of ash in the sugar, but that it also is not absolutely proportional.

It is a well-known fact that in molasses having a high ash content the difference between the reducing sugars with and without lead may reach 20, 25, or 30 per cent., *i.e.*, that the reducing sugars are actually precipitated by the lead precipitate, as has been shown by our work on the subject.

In what concerns the ash, there is evidently an insoluble portion, which cannot be counted as melassigenic matter. On account of this, the commercial rendement increases a little, but it is also sometimes decreased by a greater amount of reducing sugars.

But the certain conclusion, one that is confirmed by what we have already found with our impure Egyptian sugars, is that *the direct polarization is always, or almost always, less than the Clerget polarization*,

and that for raw sugars containing 3, 4, and 7 per cent., of reducing sugars the difference may be nearly 2 units, this difference varying according to the nature of the reducing sugars. Consequently the purchase of raw sugar should only be made by the Clerget method. For our part, we still think that it was useless to endeavour to reduce the polarization on account of the supposed influence of the lead precipitate, found to be from 0·05 to 0·2 per cent., whilst on the other hand the influence of the reducing sugars, which reduce the polarization by 0·2, 0·5, 1·0, and even by as much as 2°, was neglected. From our point of view, it is not the lead precipitate which is of account, but the action of the lead reagent itself on the polarization of the reducing sugars, rotating them a little to the right, owing to the precipitation of some of the levulose.

However, if it is thought necessary to adopt Horne's dry basic lead acetate method so as to have 0·1 or 0·2 per cent. less sugar, then, from the legal and scientific points of view it is also necessary to find the real polarization by the Clerget process. It is evident that if the Clerget process be adopted the American refiners will perhaps diminish the price of sugar a little, or of the polarimetric degree. Sellers, who have sugars containing much reducing sugars, which are very levorotatory, would have a more exact value for their merchandise in the Clerget polarization.

Moreover, in the cane sugar factory the Clerget process is the only one capable of rendering account during manufacture of the quality of the products, especially of the purity of the molasses, since certain molasses polarize 29° before inversion, and sometimes 35 or 36° after inversion. (The real dry substance matter must likewise be found by exact analysis.)

No. 1. PERUVIAN CRYSTALS: Polarization, 97·95.*
Large crystals, slightly grey.
Reaction†: alkaline. Basic lead acetate: 30 drops.‡

	Ordinary analyses.	With lead.	Without lead.
Water	0·34	0·34	0·34
Polarization	97·60	97·70	97·70
Reducing sugars	0·22	0·22	0·22
Ash§	0·48	0·48	0·45
Organic matters	1·36	1·26	1·29
	100·00	100·00	100·00
Commercial rendement	95·24	—	95·46
Lime, per cent. on sugar	—	—	0·056
,, ,, ash	—	—	11·70

*The polarizations given in the headings indicate the figure found on the same sample several months before at the time of the preparation of the samples. The differences between these and our results are easily explicable.

†This means the reaction of the solution to Pellet, delicate, neutral litmus paper.

‡The amount of basic lead acetate given here is that required to clarify a solution of 40 grms. of the sugar in about 180 c.c. of water, which was subsequently made up to 200 c.c.

§In analyses (1) and (2) the ash was determined by direct incineration with sulphuric acid, one-tenth being deducted; while in (3) it was determined on the filtered solution, and one-tenth deducted, and therefore represents the soluble sulphated ash.

No. 2. Java Basket Sugar: Polarization, 97·75.
Loose, greyish crystals.
Reaction: alkaline. Basic lead acetate: 45 drops.

	Ordinary analyses.	With lead.	Without lead.
Water	0·26	0·26	0·26
Polarization	97·75	97·90	97·90
Reducing sugars	0·55	0·72	0·80
Ash	0·48	0·48	0·37
Organic matters	0·96	0·64	0·67
	100·00	100·00	100·00
Commercial rendement	94·73	—	94·32
Lime, per cent. on sugars	—	—	0·078
,, ,, ash	—	—	16·20

No. 3. Hawaiian Centrifugal Sugar: Polarization, 96·60.
Small, loose, greyish crystals.
Reaction: alkaline. Basic lead acetate: 35 drops.

	Ordinary analyses.	With lead.	Without lead.
Water	0·74	0·74	0·74
Polarization	96·50	96·70	96·70
Reducing sugars	0·90	0·90	1·10
Ash	0·58	0·58	0·57
Organic matters	1·28	1·08	0·89
	100·00	100·00	100·00
Commercial rendement	92·38	—	91·22
Lime, per cent. on sugar	—	—	0·103
,, ,, ash	—	—	17·80

No. 4. Cuban Centrifugal Sugar: Polarization, 96·85.
Fairly large loose grey crystals.
Reaction: alkaline. Basic lead acetate: 35 drops.

	Ordinary analyses.	With lead.	Without lead.
Water	1·08	1·08	1·08
Polarization	97·10	97·10	97·10
Reducing sugars	0·45	0·55	0·60
Ash	0·56	0·56	0·52
Organic matters	0·81	0·71	0·70
	100·00	100·00	100·00
Commercial rendement	93·96	—	93·82
Lime, per cent. on sugar	—	—	0·156
,, ,, ash	—	—	27·80

No. 5. Cuban Centrifugal Sugar: Polarization, 96·0.
Medium-sized, grey crystals.
Reaction: very alkaline. Basic lead acetate: 40 drops.

	Ordinary analyses.	With lead.	Without lead.
Water	1·46	1·46	1·46
Polarization	96·20	96·30	96·30
Reducing sugars	0·52	0·70	0·65
Ash	0·90	0·90	0·87
Organic matter	0·92	0·64	0·72
	100·00	100·00	100·00
Commercial rendement	91·56	—	91·52
Lime, per cent. on sugar	—	—	0·145
,, ,, ash	—	—	16·10

No. 6. Porto Rican Centrifugal Sugar. Polarization, 94·60.
Yellow, medium-sized crystals.
Reaction: slightly alkaline. Basic lead acetate: 45 drops.

	Ordinary analyses.	With lead.	Without lead.
Water	1·30	1·30	1·30
Polarization	94·70	95·00	95·00
Reducing sugars	1·50	1·73	1·69
Ash	0·68	0·68	0·62
Organic matters	1·82	1·29	1·33
	100·00	100·00	100·00
Commercial rendement	88·98	—	89·14
Lime, per cent. on sugar	—	—	0·078
,, ,, ash	—	—	11·70

No. 7. Cuban Molasses Sugar: Polarization, 88·65.
Very fine and very grey crystals.
Reaction: very alkaline. Basic lead acetate: 70 drops.

	Ordinary analyses.	With lead.	Without lead.
Water	5·30	5·30	5·30
Polarization	89·00	88·80	88·80
Reducing Sugars	1·97	1·97	1·87
Ash	1·58	1·58	1·53
Organic matters	2·15	2·35	2·45
	100·00	100·00	100·00
Commercial rendement	78·74	—	78·94
Lime, per cent. on sugar	—	—	0·347
,, ,, ash	—	—	21·90

No. 8. Cuban Molasses Sugar: Polarization, 86·20.
Small black crystals.
Reaction: very alkaline. Basic lead acetate: 120 drops.

	Ordinary analyses.	With lead.	Without lead.
Water	4·62	4·62	4·62
Polarization	87·50	87·60	87·60
Reducing sugars	0·75	0·77	0·80
Ash	2·96	2·96	2·32
Organic matters	4·17	4·05	4·02
	100·00	100·00	100·00
Commercial rendement	74·16	—	76·72
Lime, per cent. on sugar	—	—	0·593
,, ,, ash	—	—	20·00

No. 9. Cuban Molasses Sugar: Polarization, 85·75.
Fairly large, brown crystals.
Reaction: very alkaline. Basic lead acetate, 6·5 c.c.

	Ordinary analyses.	With lead.	Without lead.
Water	4·20	4·20	4·20
Polarization	87·00	88·00	88·00
Reducing sugars	2·75	2·52	2·80
Ash	1·78	1·75	1·73
Organic matters	4·27	3·53	3·31
	100·00	100·00	100·00
Commercial rendement	74·38	—	75·48
Lime, per cent. on sugar	—	—	0·74
,, ,, ash	—	—	42·70

No. 10. Cuban Molasses Sugar: Polarization, 84·65.
Hard black mass of small crystals.
Reaction: very alkaline. Basic lead acetate: 11 c.c.

	Ordinary analyses.	With lead.	Without lead.
Water	1·56	1·56	1·56
Polarization	85·90	86·50	86·50
Reducing sugars	2·20	1·98	2·30
Ash	3·48	3·48	3·45
Organic matters	6·96	6·48	6·19
	100·00	100·00	100·00
Commercial rendement	67·58	—	68·10
Lime, per cent. on sugar	—	—	0·060
,, ,, ash	—	—	30·60

No. 11. Cuban Molasses Sugar: Polarization, 84·05.
Small brown crystals.
Reaction: very alkaline. Basic lead acetate: 10 c.c.

	Ordinary analyses.	With lead.	Without lead.
Water	4·42	4·42	4·42
Polarization	86·10	86·50	86·50
Reducing sugars	2·40	2·16	2·66
Ash	2·74	2·74	2·72
Organic matters	4·34	4·18	3·70
	100·00	100·00	100·00
Commercial rendement	70·30	—	70·30
Lime, per cent. on sugar	—	—	0·49
,, ,, ash	—	—	18·20

No. 12. Cuban Molasses Sugars: Polarization, 82·65.
Moderate sized crystals, very dark.
Reaction: very alkaline. Basic lead acetate, 12 c.c.

	Ordinary analyses.	With lead.	Without lead.
Water	3·02	3·02	3·02
Polarization	80·80	82·50	82·50
Reducing sugars	3·75	3·67	4·03
Ash	3·46	3·46	3·27
Organic matters	8·97	7·35	7·18
	100 00	100·00	100·00
Commercial rendement	59·46	—	60·96
Lime, per cent. on sugar	—	—	0·76
,, ,, ash	—	—	23·30

No. 13. Cuban Molasses Sugar: Polarization, 81·25.
Average-sized, dark crystals.
Reaction: alkaline. Basic lead acetate: 12 c.c.

	Ordinary analyses.	With lead.	Without lead.
Water	2·86	2·86	2·86
Polarization	80·80	82·70	82·70
Reducing sugars	5·20	5·73	6·20
Ash	2·93	2·93	2·83
Organic matters	8·21	5·78	5·41
	100·00	100·00	100·00
Commercial rendement	58·68	—	58·98
Lime, per cent. on sugar	—	—	0·631
,, ,, ash	—	—	22·20

No. 14. PHILIPPINE MAT SUGAR, Grade 1: Polarization, 87·85.
Sandy, yellowish crystals.
Reaction: alkaline. Basic lead acetate: 11 c.c.

	Ordinary analyses.	With lead.	Without lead.
Water	1·94	1·94	1·94
Polarization	88·20	89·50	89·50
Reducing sugars	3·90	4·61	4·66
Ash	1·53	1·53	1·35
Organic matters	4·43	2·42	2·55
	100·00	100·00	100·00
Commercial rendement	74·28	74·16	74·80
Lime, per cent. on sugar	—	—	0·195
,, ,, ash	—	—	14·40

No. 15. PHILIPPINE MAT SUGAR, Grade 2: Polarization, 84·50.
Sandy, yellow crystals.
Reaction: alkaline. Basic lead acetate: 10 c.c.

	Ordinary analyses.	With lead.	Without lead.
Water	2·16	2·16	2·16
Polarization	85·30	86·90	86·90
Reducing sugars	5·70	6·30	6·25
Ash	1·64	1·64	1·32
Organic matter	5·20	3·00	3·37
	100·00	100·00	100·00
Commercial rendement	67·34	—	69·12
Lime, per cent. on sugar	—	—	0·22
,, ,, ash	—	—	16·60

No. 16. PHILIPPINE MAT SUGAR, Grade 3: Polarization, 81·95.
Sandy, brown crystals.
Reaction: alkaline. Basic lead acetate: 10 c.c.

	Ordinary analyses.	With lead.	Without lead.
Water	2·14	2·14	2·14
Polarization	82·90	84·50	84·50
Reducing sugars	6·90	7·40	7·45
Ash	2·00	2·00	1·77
Organic matter	6·06	4·16	4·14
	100·00	100·00	100·00
Commercial rendement	61·10	—	62·52
Lime, per cent. on sugar	—	—	0·82
,, ,, ash	—	—	40·90

OBSERVATIONS.

We have tested all these samples for reaction and have found them all alkaline, using delicate, neutral litmus paper as indicator. Some were even found to be very strongly alkaline.

This fact is interesting, and shows that to obtain sugar directly from syrups the products had been kept distinctly alkaline, necessitating evidently a fairly large amount of lime for defecation.

As a matter of fact, if plenty of lime be not used for the defecation, and the juices are only slightly alkaline, this alkalinity is not maintained throughout concentration, and the juices become first neutral, and then sometimes slightly acid at the syrup stage.

It may also happen that plenty of lime may have been added, but that a portion may have become neutralized by the sulphurous acid. Still, whatever the mode of working, it is almost certain that juices very distinctly alkaline were sent to the evaporators, and that this alkalinity remained high enough not to be totally destroyed during concentrating and boiling.

As to the molasses sugars, it is probable that lime was added to the low-products to prevent fermentation during mixing. Perhaps also the after-products were themselves alkaline, and that the alkalinity of the molasses as it was set to crystallize was sufficient. However, we think that in some cases a little lime must have been added to the molasses before crystallization, or a little powdered lime spread in the crystallizers, as we have seen done in certain countries.

We have also determined the quantity of lime, expressing it on 100 parts of sugar, and also on 100 parts of ash. These results are very interesting. Generally this amount of lime varies between 8 and 12 per cent. of the ash; but here the variation is much greater, and is explicable by the presence of some particles of the nature of lime in suspension in the solution of sugar resulting from certain of the samples.

Finally, we would point out that in an article published in the *Zeitschrift des Vereins der deutschen Zuckerindustrie*, 1909 (May), 404-431, Dr. Browne has already shown that he is quite in agreement with our views.

The complete sugar crop of Louisiana for the year 1910 is put by A. Bouchereau, the statistician, at 263,308 long tons of sugar, 28,812,400 gallons of molasses, and 5,030,200 gallons of syrup. Since 1907 there has been a steady decline in the sugar and molasses output, but the syrup has increased in that period from 174,250 gallons.

An American firm have placed on the market what they call a "caterpillar tractor," being a motor traction engine, the rear part of which is carried on two pairs of wheels round which endless flat chains fitted with teeth revolve. These chains form the contact between the machine and the ground and there being about 6 feet of gripping surface on the ground at one time, it is obvious that the tractive power cannot be limited by any slipping. The "caterpillars" are besides arranged to adapt themselves to the unequalities of the ground, so should prove suitable for hauling heavy loads across ploughed fields.

Réunion.

The total production of sugar in Réunion for the year 1910 has been 39,000 tons. The following are the figures for the four previous years:—

	Tons.		Tons.
1906	43,500	1908	37,000
1907	38,000	1909	39,500

The prices averaged as follows:—

For—	Price per 100 kilos.* Fr.	c.	£	s.	d.
First quality	30	0	1	4	0
Second quality	26	25	1	1	0
Third quality	21	25	0	17	0

The average net price obtained was 26 fr. (£1 0s. 10d.) per 100 kilos. for all sugars, as against 24 fr. (19s. 2d.) in 1908 and 28 fr. (£1 2s. 5d.) in 1909.

The expenses to France, including freight, work out at about 6 fr. (4s. 10d.) per 100 kilos. (220 lbs.). These charges are at the cost of the purchaser if the sugar be sold *in situ*. The *détaxe de distance* paid on sugar amounts to 2s. on 220 lbs. of refined sugar.

The total production of rum in 1910 amounted to 923,284 gallons. Of that quantity, 144,000 gallons were consumed locally and the remainder, viz., 779,284 gallons, was exported to France and to Madagascar.

The quantities exported during the three previous years were as follows:—

	Gallons.
1907	685,908
1908	864,738
1909	859,530

The average price during the year was, locally, 25 fr. (£1) per hectolitre (22 gallons) at 54° Beaume, f.o.b. at the port of Pointe des Galets.

Holland.

At the beginning of 1910 the price of raw beet sugar was about £1 5s. per 220 lbs., and rose to £1 6s. 3d. in the middle of January and £1 10s. in April; and as raw beet sugar was scarce, this latter price was maintained until the middle of June. The abundant sugar cane crops in Cuba and Java made up for the deficiency in the beet crops and prevented a further rise in prices of raw sugar. The beet crop in the Netherlands in 1910 was estimated at 225,000 metric tons.

The margin between raw and refined was satisfactory during the last quarter of the year, but the scarcity of the raw material and the limited demand for refined sugar during the first three quarters of the year caused refiners to work at half capacity.

The number of sugar beet factories in the Netherlands is 28.

Excise duty in the Netherlands on sugar of at least 98 degrees polarization is £2 5s. per 220 lbs. (100 kilos.). The total amount of revenue under this

* 220 lbs.

head amounted to £1,858,000, £1,946,000, and £1,972,000 in the years 1908 1909 and 1910 respectively.

The Netherlands consumed the following amounts of sugar during 1910 :—

	Tons.
Raw	435
Cane	3,073
98 degrees polarization (first marks)	13,687
100 degrees polarization refined	72,395
Candied	2,087
Bastard	13,243
Total	104,920

Production in 1910.

	Tons.
Raw	177,341
First marks	35,784
Total	213,125

Imports in 1910.

	Tons.
Raw	177,544
Cane	62,230
Bastard	48,525
Total	288,299

Exports in 1910.

	Tons.
Raw	186,128
Cane	45,438
Refined	141,948
Total	373,514

Denmark.

The British Consul writes in his annual report :—

The sugar beet harvest of 1910 was abnormally large, the production being estimated at about 105,000 tons of raw sugar, as against 67,500 tons in 1909. It is true that the area devoted to beet cultivation increased about 35 per cent., but even then the yield was much greater than in 1909. The percentage of sugar contained in the beet was also most satisfactory. This is the first time in Denmark that the production has exceeded the consumption, and Denmark should now rank no longer as a sugar-importing country but among those countries which export sugar. The amalgamated Danish sugar factories have paid high dividends, though these satisfactory results, be it said, are due to long years of experiment. There is, however, one drawback connected with beet cultivation in Denmark which is worthy of mention, namely, that the ordinary Danish farm labourer is averse to taking up and

sorting the roots for delivery. To remedy this, recourse has to be had to foreign labour, reference to which is made in another part of this report.

The experiments in beet growing which have been conducted in the United Kingdom and the establishment of factories have attracted much attention in this country. Englishmen interested in the question could not do better than study the methods employed by the Danes on the spot or obtain the assistance of a first-class man in this branch of agriculture to help them in their early endeavours.

PUBLICATIONS RECEIVED.

ANLEITUNG ZUR UNTERSUCHUNG DER FÜR DIE ZUCKERINDUSTRIE IN BETRACHT KOMMENDEN ROHMATERIALEN, PRODUKTE, NEBENPRODUKTE, AND HILFSSUBSTANZEN. By Professor Dr. Frühling. Seventh revised and enlarged edition. With 140 illustrations. Friedrich Viewig u. Sohn, Braunschweig. 1911. Price, M.15, cloth M.16.

The volume under review constitutes the standard text-book for the German sugar chemist, and some idea of the place it holds may be gained from the fact that in a comparatively short period of time it has reached its seventh "revised and enlarged" edition. Its outstanding feature is thoroughness. This is at once apparent, not only in the very exact and complete description of the various processes, but also in the excellent illustrations, which for the greater part do not seem to be taken from the dealers' catalogues, but have the appearance of being specially drawn in order to assist in a better comprehension of the text. Another useful feature, one which will be appreciated by the young or inexperienced chemist, is the *Beispiel* following each process, in which a typical example is fully worked out, both the method of calculation and the method of expressing the result being given. On looking through the book, it is noticeable that place is given only to processes that are generally recognised as reliable, and that where two or more methods are described for the same determination, an effort seems to have been made to indicate their relative merits, either for speed or accuracy, which is a feature that might be copied by other text-books on analytical chemistry.

In the first section is given a detailed description of the various carbohydrates; of the construction of the polarimeter and its accessories; of the various methods of determining the density of solutions; and of the operation of the "inversion method," including the Clerget value, and the gravimetric and volumetric methods of determining reducing sugars. Following this, is the application of these processes to the examination of the different sugar house products, such as beets, raw and carbonatation juices, syrups, molasses, scums, and waste products. In these sections we are

glad to see that the refractometer is given its due place as a valuable instrument in sugar house control, although the convenient temperature correction tables of Geerligs are not included. In the description relating to the Clerget process as applied to beet molasses we are surprised to find that no mention is made of the influence of the optically active non-sugars in vitiating the determination, and of the means that should be taken to obviate their effect. Some years ago Pellet, and quite recently Ogilvie, have shown the considerable importance of taking the direct polarization in an acid medium, yet no mention is made of the use of hydrochloric and urea, nor of sulphurous acid, in this respect.

The remainder of the matter is taken up with the methods of examination of the various *Hilfssubstanzen*, as charcoal, water, limestone, caustic lime, carbonic acid gas, fuel, waste gases, manures, seed, and molasses cattle foods. In an appendix are described methods of examination for starch-glucose and invert sugar, and the preparation of the different reagents and volumetric solutions used in analytical work. Finally follow some useful tables, such as the international atomic weights (1910), thermometer scales, the percentage of alcohol by weight and by volume, alcohol dilution, &c.

Essais d'Huiles Usagées: Bulletin du Laboratoire d'Essais du Conservatoire National des Arts et Métiers, No. 16. By P. Sabatié and M. Léon Pellet. With 15 pages and 6 plates. Librairie Polytechnique, 15, rue de Saints-Pères, Paris. 1911.

For some time past engineers have been endeavouring to reduce the cost of the lubrication of their machinery, which is often considerable, by collecting the oil after it has run through the channels distributing it to the various bearings, and regenerating it in a suitable manner. In the case of mineral oils this regenerative process consists either of a thorough filtration by means of an apparatus specially designed for the purpose, or else of a treatment with steam under pressure, followed by simple decantation. In this pamphlet M. P. Sabatié and M. Pellet (son of the distinguished sugar specialist) give an account of their useful studies on the composition of lubricating oils before and after use and regeneration. From carefully conducted experiments they find that the density of lubricating oil is increased slightly by use, naturally as the result of the volatilization of the lighter constituents. Generally the viscosity remains the same, but when the filtration has been inefficient the oil after use may be more viscous, owing to the presence of a more or less amount of suspended matter. The flash-point is usually raised some degrees after use. As to the acidity, no appreciable increase could be noticed, even in the case of mixed oils, *i.e.*, those containing vegetable as well as mineral oils. In the case of these mixed oils, it was,

however, observed that the saponifiable portion decreased, on an average by nearly 2 per cent., as the result of use. Regarding mechanical tests, it is shown clearly by means of a number of curves that the coefficient of friction does not alter as the result of use. Resuming, the authors give it as their opinion that used oil, properly collected and carefully filtered, so as to free it from all matter in suspension, retains its original properties, physical, chemical and mechanical, intact.

Tafel zur Ermittelung des Zuckergehalts von Zuckerlösungen. Edited by the Kaiserlichen Normal-Eichungskomission. Published by Julius Springer, Berlin, 1911. Price, bound M.1.

This little book, edited by the German Imperial Commission of Standards, consists of a temperature correction table for reducing and converting the density of sucrose solutions to the normal temperature of 20°C. It can be used for solutions of densities as far as 70° Brix, and for any temperature up to 60°C. In an introduction is explained: (1) The effect of temperature on the density of sugar solutions; (2) the methods of determining density; and (3) the use of the tables. If the temperature is above 20°C., then the corrections given in the table must be added; but if, on the contrary, the temperature is below 20°C., the correction is subtracted. Thus *e.g.*, a juice has a density according to the spindle or picnometer of 26·45° Brix at 25·2°C., then its true density at 20°C. is 26·45 *plus* 0·35 (the correction) = 26·80° Brix. In the case of a liquor of 32·2° Brix at 16·36°C., the true density at 20°C. will be: 32·2 *minus* 0·24 (the correction) = 31·96 Brix. These temperature correction tables will be found of very great value to sugar chemists.

Facts for Inventors. A small 32mo. brochure issued by W. P. Thompson, Chartered Patent Agent, Lord Street, Liverpool, with a view to answering the multitudinous enquiries about patents and the British patent law which every agent is prone to receive at some time or other in the course of his business. Any intending patentee could not do better than procure a copy.

From the *Modern Sugar Planter*, New Orleans, we are in receipt of their annual Directory of Louisiana Sugar Planters, embracing all who manufacture Sugar and the larger ones who only grow Cane. This list will be useful for commercial houses wishing to get into touch with the Louisiana Sugar Industry. The price is $1·00 per copy.

ABSTRACTS, SCIENTIFIC AND TECHNICAL.*

THE EFFECT OF HIGH TEMPERATURES ON CANE SUGAR IN SOLUTION.

By Noël Deerr. Bull. No. 36, 1911, Hawaiian Sugar Expt. Station, Agric. and Chem. Series. Cf. Pellet, *J. Fabr. sucre de France, 1878*, and *Comptes rendus de 4em. Congres Intern. de Chemie, 1900*, tome 2, 66. Hazewinkel, this *Jl., 1910, 212, 282.* Deerr, this *Jl., 1911, 105.*

In the beet sugar factories of Europe it has been found that considerable economy can be effected by the use of high temperatures pressure steam with the Pauly-Greiner pre-heater system of evaporation. So far very few cane sugar factories have adopted this system; but before advising its introduction it is necessary to examine the behaviour of cane juices, which are not at all comparable to the beet product, using the high temperatures representative of the new practice. At the commencement of an investigation having this object in view, the author amplified the experiments of Herzfeld (*Zeitsch. Rübenzuckerind., 43, 735*) and of Douschsky (this *Jl., 1911, 46*), on the decomposition of sucrose at high temperatures in neutral aqueous solutions, employing, however, concentrations corresponding to those obtaining in cane juice, with the following results:—

Temperature.	110°C.	115°C.	120°C.	125°C.	130°C.	135°C.
Original polarization ..	78·0	78·0	78·0	78·0	78·0	78·0
Polarization after heating for 30 min. at the specified temperature	78·0	77·3	76·5	73·7	65·2	38·3
	—	—	76·2	73·0	63·0	32·1
	78·0	77·3	76·5	73·7	61·2	35·3

It is thus seen that in neutral† solution no inversion occurs below 110°C., but that above this temperature inversion sets in, becoming very marked at 125°C. In further experiments it was found that in the presence of very small amounts of alkali, inversion is very largely inhibited at all temperatures, but at 110°C. the presence of increasing quantities of alkali gradually retards the inversion until a certain point is reached, at which a further amount of alkali has no effect on the amount of sugar inverted. With neutral salts at high temperatures it was found that the chlorides, bromides, iodides, nitrates, and sulphates of the alkalis and alkaline earths materially increase the rate of inversion, in neutral or alkaline solution, in direct proportion to the amount of salt present; but that, on the contrary, the neutral salts of the weak acids, such as acetic, tartaric, or oxalic acids, retard inversion, acting thus in the same way as alkalis.

† Except for a slight amount of alkali dissolved from the glass contained.

On similarly experimenting with cane juices, it was found that conditions may vary greatly according to the amount and nature of the salts present, but that the dominant factor is the amount of free alkali (*i.e.*, the amount of lime used in tempering) present, so that a temperature which may be safe with one juice may be sufficient to cause serious inversion in the case of another. With, however, the conditions which usually prevail in Hawaiian factories, juices may be safely heated to 120°C. for half-an-hour with no measurable loss of sucrose, and perhaps even to 125° or 130°C. for shorter periods, provided proper chemical control be exercised.

In both the cane and beet industries it has been established that the highest temperature obtainable with the ordinary system of evaporation, *i.e.*, 100°C., is insufficient to destroy the micro-organisms, capable of causing deterioration on storage, that are introduced with the juice, or with the low sugars re-melted or drawn into the pans as "seed" for graining. It is a matter of considerable interest to determine whether it is not possible to increase the temperature sufficiently high to destroy these micro-organisms, without effecting any loss of sugar by over-heating or by inversion. On carrying out experiments in this direction, the important fact was discovered that it is possible to sterilize cane sugar products infected with deteriorative bacteria by raising the temperature momentarily to 125°C., and that at this temperature no loss of sucrose can be detected, provided a sufficient amount of alkali be present.

In some factories it is customary to heat the juice to 115 to 120°C. in closed tubular reheaters in order, it is supposed, to obtain an improved clarification. Using temperatures of from 100 to 130°C., and 0·15 per cent. of lime on the juice, the author found that no advantage is to be gained by employing these higher temperatures, since with them there is no difference in the brightness, the volume of precipitate, the purity, or the vicosity of the juice, a slightly greater rapidity in the settling of the dirt being the only possible advantage observed.

Summarizing this very interesting research in a word, the author states that "the use of high temperature evaporation with the preheater system of evaporation, and also the sterilization of all sugar house products, is possible under a rational system of control."

BAGASSE FURNACE DESIGN: PART 1. *By E. W. Kerr. Modern S. Planter, 1911, 41, No. 29, 2-4.*

In this article six different methods for providing for an adequate volume of combustion chamber of a bagasse furnace are discussed: (1) By the use of the Dutch oven form of design. In this type of furnace, to reduce the velocity of the gases, and effect a better combustion, the area of the cross section perpendicular to the axis of the boiler should be increased. Increasing the length of the furnace does not affect the velocity of the gases, although the length of the path

of the gases is thereby increased, and therefore also the time for combustion. As to the area of the outlet from the Dutch oven to the boiler setting, the author considers this should be relatively small, so as to induce the gases to remain in the furnace, the highest temperature being thus thrown to the front part of the oven, which has the effect of causing a higher temperature, and in consequence a more thorough combustion. Just how small this the area of this outlet should be made is not definitely stated, for other conditions in each plant have to be considered. Usually, however, the top of the bridge wall forms one edge of the outlet, and it is quite easy to vary the opening by laying up bricks on the top of the bridge wall until the best conditions in the furnace are found, a matter that can be facilitated by the use of a draught gauge. (2) By properly utilizing the space behind the bridge wall. What the writer has to say on this point has special reference to the setting for horizontal return tubular boilers. In some designs the back of the bridge wall drops perpendicularly to the level of the boiler room floor, there being a large space between the back of the bridge wall and another wall placed in front of a mud drum to protect the latter from the heat; whilst in others there is no mud drum, the entire space behind the bridge wall serving as a combustion chamber. In nearly every respect the latter arrangement fulfils the conditions necessary for the economical combustion of the fuel, and appeals to the writer as being the best. It not only gives an increased combustion space, but it also reduces the possibility of cooling the gases below the ignition temperature by removing them further from the shell of the boiler. (3) By fixing a flame wall made of tile, resting on the lower layer of the tubes of certain types of boilers, as the Babcock and the Wilcox, or the Heine, for a considerable distance away from the bridge wall. This has the effect of increasing the volume of the combustion chamber, since the contact of the gases with water cooling surface is prevented. (4) By increasing the length where horizontal return tubular boilers are used, which aids in securing more complete combustion of moist fuels, especially when the portion behind the bridge wall is left open, and where the gases are not compelled to move along in close contact with the underside of the boiler shell. (5) By increasing the vertical distance from the grate to the underside of the boiler shell. This becomes especially necessary where the grate is placed directly under the boiler, although in general the distance depends upon the fuel, very moist materials requiring the greatest. (6) By removing the grate, and burning the bagasse upon a brick hearth at the ground level, which gives the effect of great height of furnace. In such an arrangement air is supplied from the side, by forced draught, the Dunn and Sutcliffe furnace being an example of this type.

Abnormally High Gum Content of Juices, Syrups, and Molasses. *By J. J. Hazewinkel. Archief (Java), 1910, 18, 44-45.*

On a certain Javan estate much trouble was experienced by the formation of false grain when boiling both first and after products. All efforts to rectify this state of things were of no avail, and boiling could only be conducted with extreme slowness, and at the expense of the efficiency of the pans. On investigating this irregularity, it was established that a very high gum content of the juices, syrups, and molasses was at fault; and further experiments showed that the gum contained in the thin-juice persisted throughout boiling, and was all found in the molasses, the amount actually determined being approximately 8 per cent. of the dry substance. An idea of the considerable influence exerted by the presence of this gum may be obtained from the fact that on warming some of the thick-juice with a little acetic acid the liquid was coagulated, and on cooling set to a solid mass. In the molasses, especially high amounts of glucose were found, while purity values as low as only 24° were even observed. It is perhaps noteworthy that the estate in question always happens to have more trouble from this source in wet than in dry seasons, and it is quite conceivable that climatic conditions, taken in conjunction with the situation, may be conditioning factors. Further, milling on this estate was less easily conducted than usual, in spite of the fact that the general conditions were more favourable than in the previous year, so that the author infers that unripe cane had been worked. He points out that it is very improbable that *Leuconostoc* was the cause of the trouble, and that everything appeared to preclude the supposition that this organism had been at all concerned in this abnormally large formation of gum.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E. Chartered Patent Agent, 6, Lord Street, Liverpool; 77, Market Street, Bradford; and 285, High Holborn, London.

ENGLISH.—Applications.

8381. G. Barker. (Communicated by Henning Process Sugar Extraction Co., U.S.A.) *Process of manufacturing sugar.* (Complete specification.) 4th April, 1911.

8810. J. Mugg. *Machinery for forming cakes of cattle food and other plastic or semi-plastic materials.* 8th April, 1911.

9295. M. G. Hummelinck. *Apparatus for continuously melting sugar and other fusible substances.* (Complete specification.) 13th April, 1911.

9802. F. Maxwell. *Hydraulic cylinder covers of sugar cane mills, and means for securing the same.* (Complete specification.) 22nd April, 1911.

11546. C. Rost. *Apparatus for boiling sugar for manufacturing bon-bons.* (Complete specification.) 12th May, 1911.

Abridgments.

1027. W. Mackie, Govan, Lanark. *Improvements in hydraulic pressure regulating gear for sugar cane mills and the like.* (Date of application, 14th January, 1911.) This invention has for its object in hydraulic pressure regulating gear for sugar cane mills, a plug-like cylinder cover fitting within an aperture in the housing cap, in which aperture is an inwardly projecting interrupted flange co-acting with a counterpart outwardly projecting flange on the cover, and a shoulder or equivalent supporting the cover, there being a packing device between cover and cylinder aperture and a means for locking the cover in the aperture, with or without helicoid surfaces upon the flanges or upon the shoulder and cover.

German.—Abridgments.

232923. Separator Aktiebolaget Fama, of Stockholm. 27th November, 1909. *A centrifugal drum of helically wound wire.* A spiral or helical wire on which the cover ring is screwed is inserted between the upper coils of the drum casing of this centrifugal in such a way as to project beyond the external periphery of the drum.

233204. Joseph Schoemann, of Aix-la-Chapelle. 17th September, 1909. *A centrifugal the strainers or sieves of which lie on both sides on partitions which are revoluble and capable of being rendered stationary, and which form the drum.* The imperforate partitions on their sides which face the sieve or straining surfaces are provided with vertical passages which lead to an overflow arrangement.

Note.—Copies of all published specifications with their drawings in these lists can be obtained from W. P. Thompson & Co., 6, Lord Street, Liverpool, at One Shilling each copy for English or American Patents, and Two Shillings for German. In ordering please give number and date.

UNITED KINGDOM.

IMPORTS AND EXPORTS OF SUGAR
To End of May, 1910 and 1911.

IMPORTS.

Unrefined Sugars.	1910. Tons.*	1911. Tons.*	1910. £	1911. £
Russia	....	....	....	....
Germany	90,089	258,060	1,215,476	2,606,103
Netherlands	4,834	3,272	57,991	30,032
Belgium	2,931	3,502	36,127	33,020
France	404	44	5,864	393
Austria-Hungary	38,942	35,004	520,437	349,483
Java	101	6	1,104	67
Cuba	68,065	2,604	963,193	20,009
Dutch Guiana	2,777	3,364	39,219	38,988
Hayti and San Domingo	49,629	18,923	693,760	202,875
Mexico	7,659	5,023	109,676	57,841
Peru	31,345	15,784	421,791	146,731
Brazil	38,363	7,139	465,976	59,090
Mauritius	20,692	17,770	306,382	150,720
British India	4,843	....	52,004	5
Straits Settlements	792	....	9,389	....
Br. West Indian Islands, Br. Guiana & Br. Honduras	44,351	31,142	643,740	424,811
Other Countries	9,638	8,600	124,363	80,674
Total Raw Sugars	415,460	410,235	5,666,492	4,200,842
Refined Sugars.				
Russia	94	22,564	1,452	275,211
Germany	158,664	177,141	2,474,465	2,289,374
Holland	39,182	51,396	635,998	700,176
Belgium	11,776	15,137	198,233	207,908
France	40,257	2,462	658,216	36,158
Austria-Hungary	83,441	83,956	1,347,557	1,102,520
Other Countries	24,954	81	426,444	1,013
Total Refined Sugars	358,367	352,737	5,742,365	4,612,360
Molasses	73,642	57,387	343,352	231,238
Total Imports	847,469	820,359	11,752,209	9,044,440

EXPORTS.

British Refined Sugars.	Tons.	Tons.	£	£
Denmark	1,701	1,748	24,004	20,097
Netherlands	1,360	1,221	21,058	16,078
Portugal, Azores, & Madeira	534	565	7,503	6,412
Italy	121	653	1,655	7,525
Canada	2,479	3,297	39,035	48,038
Other Countries	3,262	5,562	60,246	84,712
	9,457	13,045	153,501	182,862
Foreign & Colonial Sugars				
Refined and Candy	257	410	4,882	6,354
Unrefined	1,812	3,753	25,827	43,267
Various Mixed in Bond	30	....	480	....
Molasses	156	204	1,164	1,398
Total Exports	11,712	17,412	185,854	233,881

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1911. Tons.		1910. Tons.
Total Receipts January 1st to May 31st	1,117,770	..	1,232,688
Receipts of Refined ,, ,, ...	227	..	149
Deliveries ,, ,, ...	1,076,333	..	1,169,550
Importers' Stocks, May 31st	41,437	..	66,488
Total Stocks, June 7th	267,000	..	379,570
Stocks in Cuba, ,, ...	252,000	..	320,000
	1910.		1909.
Total Consumption for twelve months ..	3,350,355	..	3,257,660

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR FOR 1909, 1910 AND 1911.

(Tons of 2,240 lbs.)	1909. Tons.		1910. Tons.		1911. Tons.
Exports	778,374	..	933,189	..	785,933
Stocks	392,259	..	456,714	..	403,898
	1,170,633	..	1,389,903	..	1,189,831
Local Consumption (4 months)..	21,630	..	22,140	..	22,690
	1,192,263	..	1,412,043	..	1,212,521
Stock on 1st January (old crop)..	....	..	....	..	....
Receipts at Ports up to 30th April	1,192,263		1,412,043		1,212,521

Havana, 30th April, 1911. J. GUMA.—F. MEJER.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION OF SUGAR FOR FIVE MONTHS ENDING MAY 31ST.

	Imports.					Exports (Foreign).				
	1909. Tons.		1910. Tons.		1911. Tons.	1909. Tons.		1910. Tons.		1911. Tons.
Refined	431,327	..	358,367	..	352,737	335	..	257	..	411
Raw	327,388	..	415,460	..	410,235	1,349	..	1,842	..	3,753
Molasses	64,429	..	73,642	..	57,387	55	..	156	..	204
	823,144		847,469		820,359	1,739		2,255		4,368

	Home Consumption.				
	1909. Tons.		1910. Tons.		1911. Tons.
Refined	428,503	..	341,542	..	342,386
Refined (in Bond) in the United Kingdom........	247,412	..	247,923	..	263,650
Raw	52,812	..	54,078	..	47,892
Molasses	59,222	..	65,143	..	53,000
Molasses, manufactured (in Bond) in U.K........	33,048	..	30,986	..	34,252
Total..........................	820,997	..	739,672	..	741,180
Less Exports of British Refined.................	12,353	..	9,457	..	13,045
	808,644		730,215		728,135

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, MAY 1ST TO 31ST. COMPARED WITH PREVIOUS YEARS.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1911.
167,700	1,137,730	319,480	507,600	239,350	2,371,860

	1910.	1909.	1908.	1907.
Totals ..	..1,913,550..	2,253,130..	2,342,070..	2,476,140.

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING APRIL 30TH, IN THOUSANDS OF TONS.

(Licht's Circular.)

Great Britain.	Germany.	France.	Austria-Hungary	Holland, Belgium, &c.	Total 1910-11.	Total 1909-10.	Total 1908-09.
1918	1323	736	638	240	4855	4688	4670

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1910-1911.	1909-1910.	1908-1909.	1907-1908.
	Tons.	Tons.	Tons.	Tons.
Germany	2,602,000 ..	2,027,000 ..	2,082,848 ..	2,129,597
Austria	1,570,000 ..	1,257,000 ..	1,398,588 ..	1,424,657
France	740,000 ..	801,000 ..	807,059 ..	727,712
Russia	2,115,000 ..	1,145,000 ..	1,257,387 ..	1,410,000
Belgium	285,000 ..	250,000 ..	258,339 ..	232,352
Holland	225,000 ..	198,000 ..	214,344 ..	175,184
Other Countries .	590,000 ..	460,000 ..	525,300 ..	462,772
	8,127,000	6,138,000	6,543,865	6,562,274

THE

INTERNATIONAL

SUGAR JOURNAL.

No. 151. JULY, 1911. Vol. XIII.

☞ All communications to be addressed to the Editor, Office of "The Sugar Cane," Altrincham, near Manchester. All Advertisements to be sent direct.

☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

Cheques and Postal Orders to be made payable to NORMAN RODGER, Altrincham.

The Editor will be glad to consider any MSS. sent to him for insertion in this Journal and will endeavour to return the same if unsuitable; but he cannot undertake to be responsible for them unless a stamped addressed envelope is enclosed.

NOTES AND COMMENTS.

Cane Harvesting Machinery.

We must supplement the comments we made in our last issue on the lack of successful cane cutting machinery by the statement that there is a machine experimentally at work in Cuba, which promises very well, though it has not yet been tried on a really commercial scale. Our source of information is that interesting publication, the *Cuba Review*,* from which we cull the following particulars:—

The Hadley Cane Harvester, as the machine is called after its inventor, is the product of six years' experimentation, and the designer considers it now as practically complete. The cane is cut by revolving discs that work at the surface of the ground, or even a little below the surface. The cane is stripped while passing through the throat of the machine by rapidly revolving "whippers." After being stripped it falls on an "endless apron" that conveys it to the topping saw. It is pulled against this topping saw by hand, in order that it may be topped at the right place. After topping, the cane is carried up by a conveyor to an elevated basket or receptacle, capable of holding and carrying several hundred pounds. From this catcher it is dumped directly into a cart which is driven alongside of the machine. The harvester is double-ended, so that it cuts to and fro across the field. The frame is light, but strong, being made of quadrangular piping, and it is driven by a powerful gasolene motor.

* Published by the Munson Steamship Line, New York.

Of course, such a machine could only be used on land free from stumps, stones, or other obstructions.

It has, however, been tried in the cane fields of Central Luisa, Jovellanos, Cuba, for the past two seasons, and seems to have yielded successful results. Mr. F. S. Earle, the former director of the Cuban Government's agricultural experimental station, has been superintending the working this season, and he considers this harvester an exceedingly interesting and promising invention. The cane is cut lower and more uniformly than is usually done by hand, and the stripping and topping have been satisfactory. Its trial on a large scale will therefore be awaited with considerable interest on the part of all planters who are troubled by the scarcity of cheap labour.

Where the First Beet Sugar was made.

The accompanying photograph, specially taken by the courtesy of the Director of the Sugar Institute in Berlin, represents the building

in which Achard made his first beet sugar. The output of this little factory was 6 tons per annum. The world's production of beet sugar is now, of course, something like 8½ million tons.

New Filtering Medium for Sugar Cane Juices.

The Australian Sugar Journal states that during the last two seasons fine wood shavings, or "wood wool," have been used at the Pleystowe Mill, Mackay, as a filtering medium for cane juices, with

great success. The clarified juices, after coming from the subsiders, are run by gravity through two filters for from 10 to 12 hours; the juice is then run into two more filters which have clean shavings in, and the dirty ones are opened up. In these the shavings will be found to be coated with a dirty black slime. This slime is the most serious thing sugar manufacturers have to cope with in their evaporating plants, as it clings to the tubes, and causes a scale which is very hard to get off. During last season, especially, it was noticed that, although the triple effect did 25 per cent. more work than it ever did before, the tubes always kept fairly clean, thus lessening to a great extent the hard labour of Sunday cleaning.

The only attendance required to work "wood wool" filters is one man for about 1½ to 2 hours per shift. This is required for changing the shavings, washing them, and putting them back again. The juice goes in by gravity, and a pump to raise the filtered juice to the triple effect supply tank is controlled by a float valve, thus requiring no attendance. The shavings last for a considerable time, being used over and over again. A further advantage is that there is no scoring of the pump brasses, as is the case where sand is used for filtering, the pump working as smoothly at the end of the season as at the beginning.

Patent Law in Japan.

It is not more than a decade since the sugar industry began to develop in Formosa, and owing to the unexampled encouragement bestowed on it by the Japanese Government, the increase in the production of this staple has been wonderful. This may be easily seen when we say that in 1904 the output was but 80,000 tons, and in 1908 but 110,000 tons, while it was nearly 300,000 tons in 1910. At present fourteen companies and thirty-one factories, with all the latest equipments, are working, so that an annual yield of over 500,000 tons will soon be quite probable. Besides cane sugar, the fact must not be overlooked that many schemes for the making of *beet sugar* in the new dependency of Corea have been progressing recently.

In consideration of these circumstances, there is no doubt that all the concerns competitively engaged in the production of sugar in Japan will take the utmost care to adopt any new improvement either in machinery or in process of manufacture, no original expense being spared in the endeavour to get the best sugar at the least cost. Things being in this condition at the present time, we can offer no better advice to all foreign machinery makers or inventors of manufacturing processes than to apply for patents to the Government of Japan, in order to promote their interests and protect themselves from any infringement of their patent rights. It cannot be too strongly

emphasized that in the case of any patent, applied from or granted by a Government other than Japan, being counterfeited or copied in Japan, either in exact duplicate of the original or slightly modified, the foreign patentee could not claim anything against this imitation, unless he had already applied to the Japanese Government for a covering patent and received it. This precaution will be even more necessary after the new tariff of higher rates on imported machines comes into force.

A firm of patent agents that is in very close communication with the sugar industry of Japan is Messrs. Isomura & Co. of Tokyo. Mr. H. Isomura, one of the partners, was in Formosa for ten years as superintendent engineer of certain large sugar factories; this long experience and the recommendation of many friends eventually decided him to start as a consulting engineer, and as technical adviser of several factories. Dr. T. Odamura, another partner, is a licensed Patent Attorney. Thus, the joint efforts of these two gentlemen would be most opportune in the business of securing and working Japanese patents in sugar. Their address is 9, Shibaguchi, Tokyo, Japan.

English Capital in Cuba.

A correspondent of *The American Sugar Industry* in Cuba states that English capitalists are beginning to see the advantages offered by the sugar industry in Cuba, and there are no less than five enterprises backed by London and Liverpool financiers investigating opportunities there at the present time. Sugar properties already owned by English interests have in the past several years earned such large dividends and give promise of such additional ones; and the fact is being slowly realized that Cuba offers better and more certain returns for the money invested than any other field open at present to the English investor. It is beginning to look as if the recent rubber boom experienced in England is to be repeated in sugar stocks and bonds, with the great advantage that the latter will represent certain profits while the former is rather problematical. English companies which have bought virgin lands in Santiago and Camaguey provinces have gone to work systematically to clear up the dense growth of native hardwoods preparatory to planting sugar cane. The monetary yields from these dense forest tracts have served to astonish the most sanguine investors owing to the most extraordinary amount of marketable mahogany and Spanish cedar logs available, not to mention the income from other hardwoods almost equally as valuable and from charcoal made from woods unserviceable for other purposes. It is claimed in some instances that the income from the clearing of these tracts is equal to the purchase price of the property, so that the rich sugar land left after the woods are removed appears to have cost nothing. It is predicted that no less than five millions of English

capital will be invested in Cuba within the next twelve months if present prospects continue.

The St. Kitts Central.

We note with pleasure that an extraordinary General Meeting of the St. Kitts (Basse Terre) Sugar Factory Ltd., was held at the Company's Offices on the 14th June last at which it was unanimously agreed to increase the capital of the Company from £75,000 to £100,000 in order to enlarge the works now under construction. The Directors were at the same time authorised to increase the capital by the further amount of £30,000 if and when it should be found necessary. We feel sure that the foresight of the Directors in obtaining increased powers for future extensions will be fully justified. These steps have been taken in consequence of the enthusiastic reception of the scheme in St. Kitts, emphasized by the very liberal subscription for shares not merely by the planters but by all classes in the island, by the hearty approval of the local government, and by the fact that the ample supplies of cane already contracted for will be drawn from a limited number of estates extending from "Brighton Estate" on the one side, to "West Farm Estate" on the other.

We hope in the near future to be able to inform our readers that it has been found necessary to establish a branch factory to deal with the estates at present unavoidably omitted, and we have in conclusion only to express our best wishes for the prosperity of the new Company and our belief that the system will be rapidly extended to the whole of the Leeward Islands.

Danger of Fire in Sugar Refineries.

Superintendent F. J. T. Stewart, of the New York Board of Fire Underwriters, in his report on recent fire in Arbuckle Brothers' sugar refinery, Brooklyn, says (according to the *American Sugar Industry*): This fire shows clearly the hazard attending the pulverization of sugar and the need for conducting this process in a separate building, or the process should be conducted in a section cut off by a 12-inch fire wall without direct openings to other buildings. The outer unexposed wall preferably to be of light material such as plaster on wire lath, or terra cotta blocks, so that the force of any explosion may be vented outward. No dust room should be used. Dust from granulators and pulverizers should be settled by spraying in an enclosed chamber of incombustible material, thus eliminating the hazard of the dust room and dust tubes. "All pulverizing mills should be equipped with magnets and some form of explosion preventer. The location of machinery and conveyors should be such as to necessitate as few floor openings as possible and stair and elevators should be enclosed in a standard manner. A bad feature of this plant was the wooden sugar

bins passing through the sixth floor. When these burned they not only made large openings in the floor, but the burning sugar flowed over the floors, adding to the intensity of the fire. These bins should be replaced by some form of incombustible oonstruction."

In our issue of May, 1911, there appeared an article on "The Guanica Centrale, Porto Rico," which owing to our taking it from indirect sources was, we regret to find, uncredited to its original publication. We therefore take the first opportunity to point out that the article in question was compiled by Mr. J. R. Bovell, F.L.S., F.C.S., Superintendent of the Barbados Department of Agriculture, and first appeared in the *West Indian Bulletin*, to which journal we offer our apologies.

RUSSIAN SUGAR NOTES.

The question of most importance from the material point of view affecting the Russian sugar industry at the moment is what is going to be the quantity of beetroot as a result of this year's sowing, and this will, as it always has done, largely determine the course of the market before the ensuing campaign. It will be remembered that the harvest of beetroot last year was an altogether extraordinary one and had the effect of depressing prices, quite independent of the extraordinary steps which the Government felt compelled to take in order to obviate what threatened to be a sugar famine in the country, as the result of the speculative manœuvres of certain financiers in Kieff and Moscow.

This year a much larger area of land has been put under sugar beet and, given fairly good weather, will probably result in an even larger harvest than last year; but inasmuch as the excess in the production last year arose largely from the extraordinary development of the root under wet weather, favoured later, just before the gathering, by some fine dry weather which enriched the root, we may presume that unless something like similar weather conditions prevail this year the extra acreage sown will not be a safe index of the extra sugar to be produced. Should the weather conditions however be as favourable, the glut of raw sugar on the market that may be foreseen will yield nothing but disaster to the producers, for it is known that they have enough to do even now to keep prices from falling to a ruinous level. This has been so much the case that producers of refined sugar have found it expedient to reconstitute their syndicate, whilst producers of raw are also holding meetings with the object of coming to a common agreement respecting the quantity of raw sugar they will put on the market.

It had been decided at one of these meetings that something like 10 per cent. of the production should be held in reserve, a condition

being that practically all those who had not attended the meeting should be induced within a certain period to give their written adhesion to the decision arrived at. But unfortunately for the industry those who did not think it worth while to attend the meeting have not signified their adhesion either by writing or by word of mouth and even a number of those who did attend the meeting failed to send in their written acquiescence in what was a unanimous decision. Furthermore, a complication has supervened respecting this proposed general understanding, in that some of the sugar producers in the South-west district have their position already assured. They have sold well forward and are not in need of the assistance of an understanding to put them into a safe position. They constitute, therefore, the weakest point in the negotiations taking place, and it really is a moot question whether the raw sugar combine will ever materialize, at all events until it is known what sort of a beetroot harvest they are going to have. It is recognised, however, and this is of particular interest perhaps to English importers, that even should the producers agree to hold back 10 per cent. of their production in the form of a reserve it is more than sufficent to relieve the market of the pressure of too much stock. It has therefore been suggested that measures be taken to export sugar to the Convention markets to the full extent of the limit allowed Russia. This it is thought would take something like 5,000,000 poods (about 80,000 tons) off the inland market and certainly would constitute a considerable relief.

But even that, when it is considered that the market is now labouring under the pressure of an overplus, either existing or immediately prospective, of about 32,000,000 poods of sugar, and the 5,000,000 poods to be put in reserve as per proposed agreement, plus the (say) 5,000,000 poods to be exported, will by no means do away with the heavy stock of reserves that has threatened prices.

As it is, the refined sugar producers feel the pressure very keenly. They have met months ago, reconstituted their syndicate, and fixed the price; but they have been unable to keep the prices up to the level established It has given way appreciably and threatens to give way still more. It is easy to foresee in the near future that, unless the sugar producers can be got to act more harmoniously than they have done hitherto, we are in front of a collapse in the sugar trade which will amount to nothing short of a disaster in Kieff and Moscow financial circles. It must not be forgotten that the sugar operations in Russia involved a number of highly respectable banks and are not left in the hands of speculators pure and simple. Consequently any disaster or collapse such as suggested must prove to be a very serious matter in the financial and economic fibre of Russian business society.

A feature that has to be taken into account is one already referred to, namely, the very successful year enjoyed by Russian producers in 1909-10 which has had the effect of calling into existence new organizations for producing a larger quantity of the article and so taking advantage of the good times that appeared to be in store for the industry. After all, it must not be forgotten that the Russian market is of necessity, or almost so, one of rapid progression as a sugar consumer. Firstly, because the population increases to a considerable extent yearly. That means, even on the present basis, an appreciable increase in sugar consumption. But there is more than that. Sugar continues to reach different strata of Russian society, and it might almost be said that as a sugar consuming community the Russian population has been little more than tapped. If, as has been suggested lately and discussed with great formality at their congress in Moscow, the Russian Government should take it into its head, which is by no means impossible, that it can use its spirit-selling organization for selling sugar to the poorer elements of the population at prices much less than they can buy it at now, it goes without saying that the offer itself, including of course the lower prices, would create an extraordinarily large demand, and would create in Russia proper an absorption of sugar that might after all do more for the sugar mills than could any tinkering with reserves or forcing of the export movement. But to do this in time to save the sugar industry seems hardly possible. It looks reasonable enough that if the Government stepped into the market and became a retailer of sugar, which it has shown a disposition to do more than once, not only would the present extra stock of sugar be rapidly absorbed but there would be a demand for considerably more than could be got out of harvests of beetroot such as last year's was and this year's promises to be.

Meantime the industry is booming. Sugar is being produced in large quantities, new mills are being erected, old mills are being extended, and if evidence were wanted that these statements are not made in the air but are the result of careful inquiry and co-ordination of statistics collected, the confirmation would be found in a statement just issued by the South Russian Congress of Coalmasters, showing how the coal mined in South Russia has been disposed of during the first four months of this year. The statement shows that whereas in the corresponding period of 1910 the quantity taken for sugar factories was 9,200,000 poods, this year the quantity had risen to 16,000,000 poods. These figures are the more remarkable in that for some time back in South Russia there has been a considerable movement in favour of reverting to oil fuel where pit coal had taken its place during the high prices in and immediately succeeding the year 1905. Presuming that this movement has continued, it is quite likely the increase from 9,200,000 poods to 16,000,000 poods in coal consumption in the sugar

factories does not represent all the increase in fuel being used by the said factories. Numbers of them are probably using an increased quantity of *mazout*, or for the matter of that, even crude petroleum. Everything points to the sugar production of the country growing rapidly and of a wise internal economy finding a market for it within the limits of the Russian Empire itself.

EFFECT OF VARIOUS SOLVENTS ON SULPHATE SCALE.

By S. S. Peck,

Chemist, H.S.P.A. Experiment Station, Honolulu, Hawaii.

A scale from the tubes of a triple effect recently submitted to this Station for analysis and advice as to the best method of removal, had the following composition:—

Moisture	3·46
Organic matter (loss on ignition)..	21·92
Copper	3·20
Silica..	9·32
Iron and aluminium oxides	·15
Lime	26·90
Magnesia	·46
Phosphoric oxide	2·63
Sulphuric oxide	31·36
Oxalic acid	·38

The insoluble mineral matter of this scale, excluding the copper, which is accidental and due to the excessive scraping necessary to separate the scale from the tubes, would be approximately as follows:

Silica	9·32
Calcium sulphate	53·31
Calcium phosphate	5·74

The incrustation would then be classified as a sulphate scale. The methods of removal generally prescribed for such an incrustation are a preliminary boiling with caustic soda or carbonate of soda, followed by washing with water and a shorter boiling with weak muriatic or sulphuric acid, preferably the former. The basis of this method is the conversion of the calcium sulphate into the corresponding carbonate or hydroxide salt, and the easier solubility of these in acid. The alkali has in addition a loosening or disintegrating effect on the scale, making the action of the acid more energetic and complete. Whilst the success of these methods has been demonstrated in practice, we have thought it of interest to determine the specific action of each solvent on a scale of this type.

It is, of course, manifestly impossible to duplicate the boiling-out process as it obtains in practice by laboratory experiments. The scale exists on the tubes of the evaporators as a close, compact covering, offering a very little surface to the action of the solvents. After being scraped from the tubes, the scale was in a more or less powdery condition, and was further broken up in order to prepare a homogeneous

sample. In this form the solvents have naturally a more potent effect, but the results should show very closely their relative actions.

Two grms. of the scale were used in each test. This would have the following composition:—

	Grm.
Moisture..	·07
Organic matter (loss on ignition)	·44
Mineral matter	1·49

To this amount in a beaker 100 c.c. of solvent were added, brought to a boil and boiled for half an hour. During this operation the beaker was kept covered with a watch-glass, and water added at intervals to keep the contents at a constant volume. The solution was filtered under suction in a Gooch crucible in which was a mat of asbestos which had been previously digested with alkali and acid, washed, dried, and ignited. The residue was transferred with cold water, and washing continued until the total amount of liquid passing through the filter amounted to 250 c.c. The crucible was dried at 110°, and the gain in weight recorded as total residue. It was then burned in a muffle furnace, and the loss called organic matter. Where both alkali and acid were used, the alkali was added first, boiled for half an hour, and the supernatant liquid decanted through the Gooch. The residue was washed with about 25 c.c. of water, 100 c.c. of acid added, and again boiled for half an hour. In the last fitration washing was continued until 250 c.c. passed through.

The solvents used were hydrochloric and sulphuric acids, of a strength of one part of concentrated acid in 100 of water; and sodium carbonate and sodium hydroxide, of a strength of 1 grm. in 100 c.c. of water. The following table gives the amounts of materials removed by each treatment:—

DRY MATTER REMOVED.

Solvent.	Total Residue.		Organic Matter.		Mineral Matter.	
	Grm.	Per cent.	Grm.	Per cent.	Grm.	Per cent.
(Original)	1·93	—	·44	—	1·49	—
Water	·68	35·2	·27	60·9	·41	27·5
Hydrochloric acid	1·23	63·7	·36	81·8	·87	58·4
Sulphuric acid	·92	47·7	·28	63·7	·64	43·0
Carbonate of soda	·39	20·2	·15	34·1	·24	16·1
Caustic soda	·90	46·6	·23	52·3	·67	45·0
Carbonate of soda and Hydrochloric acid	1·44	74·6	·36	81·8	1·08	72·5
Carbonate of soda and Sulphuric acid	1·09	56·5	·30	68·2	·79	53·0
Caustic soda and Hydrochloric acid	1·32	68·4	·33	75·0	·99	66·4
Caustic soda and Sulphuric acid	1·22	63·2	·35	79·5	·87	58·4

The first column under each heading gives the weight of the respective materials removed from 2 grms. of scale, the second recording the percentage on the original.

The best result was obtained with sodium carbonate and hydrochloric acid. The best result with a single solvent came from the use of hydrochloric acid. Caustic soda followed by hydrochloric acid was inferior in its effect to carbonate of soda and the same acid, although when used alone it was far more effective than the carbonate alone.

The alkalies had but little solvent action on the organic matter of the incrustation, being inferior in this respect to water. The nature of the residue after boiling with alkali was entirely changed, being of a light and powdery appearance. The amount of mineral matter removed by the carbonate is almost quantitatively explained by the conversion of the calcium sulphate into the less heavy calcium carbonate. Assuming that all the sulphuric oxide was in combination with lime, there would be 1·06 grms. of the sulphate in 2 grms. of the material, and according to the proportion 136 : 100 = 1·06 : ·78, that amount of material would lose ·28 grm. in weight, when all the lime remains as carbonate. As the table shows, ·24 grm. of mineral matter was removed; or it would be in this case better expressed by saying that the mineral matter changed in weight to that extent, since this loss results from a change in combination of the predominant element, lime.

It is not possible to say that a change similar in its nature was performed by the caustic soda, according to the formula

$$CaSO_4 + 2NaOH = Na_2SO_4 + CaO.H_2O,$$

but the results would confirm such a statement. 1·06 grms. of calcium sulphate would be converted into ·44 grm. of the oxide, indicating a loss of ·62 grm., whilst the loss actually observed amounted to ·67 grm.

In these experiments the use of sulphuric acid following that of the carbonate was inferior in its effect to that of hydrochloric acid. This is due, of course, to the reformation of the sulphate of calcium when the acid is placed on the carbonate, and the insolubility of this salt in the amount of water used for washing.

It is reported that the Russian Council of Ministers has fixed the quantity of sugar for issue on the home market during the season 1st September, 1911, to August 30th, 1912, at 73,000,000 poods (about 1,168,000 tons), and the total normal production at 91,000,000 poods (or 1,454,000 tons). The obligatory inviolable reserve is fixed at 8,000,000 poods (128,000 tons), while owing to the strong demand from the Persian market the sugar export limit is to be as high as 10,000,000 poods.

MAMMOTH PUMPS.

In a recent issue of this *Journal* (1910, 246), a Bohemian Sugar Factory was described. It was mentioned that a mammoth pump was used for lifting the sugar beet. As pumps of this description have found very wide application in beet sugar factories, we give below a brief description of them.

Fig. 1 represents the mammoth pump for conveyance of beet.

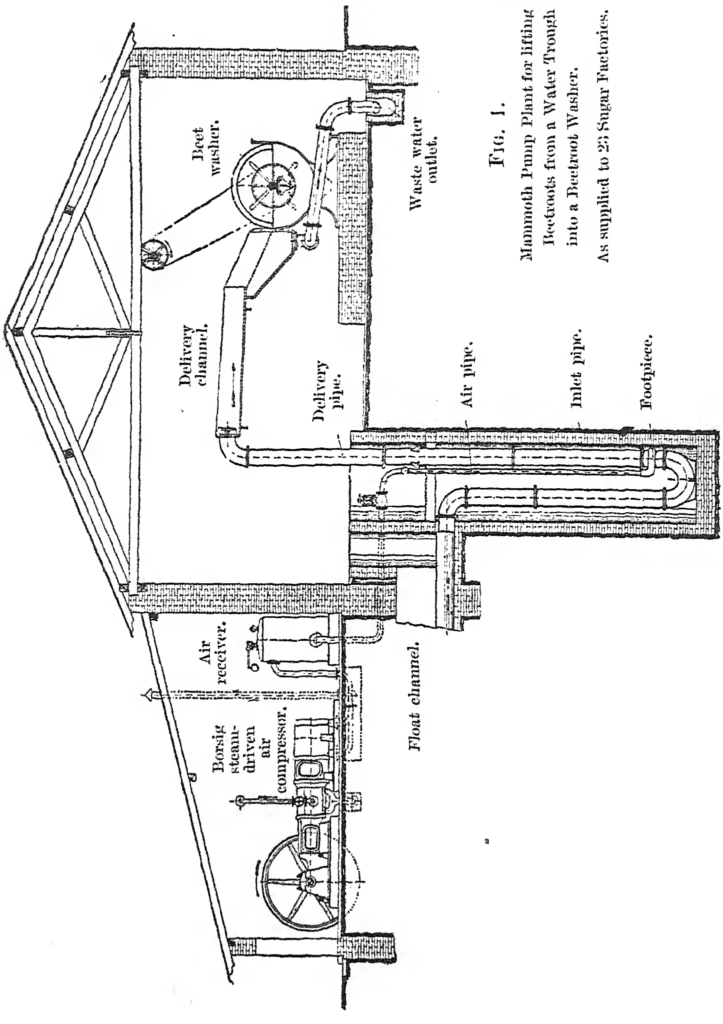


Fig. 1.
Mammoth Pump Plant for lifting Beetroots from a Water Trough into a Beetroot Washer.
As supplied to 23 Sugar Factories.

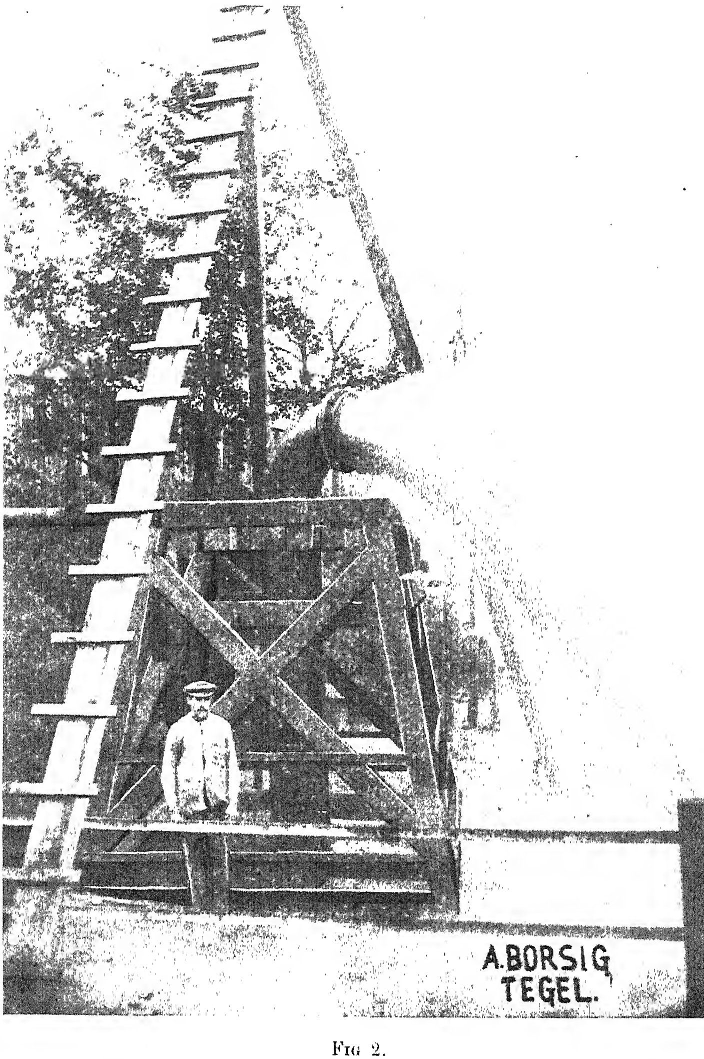


FIG 2.

OUTFLOW END OF A MAMMOTH PUMP.

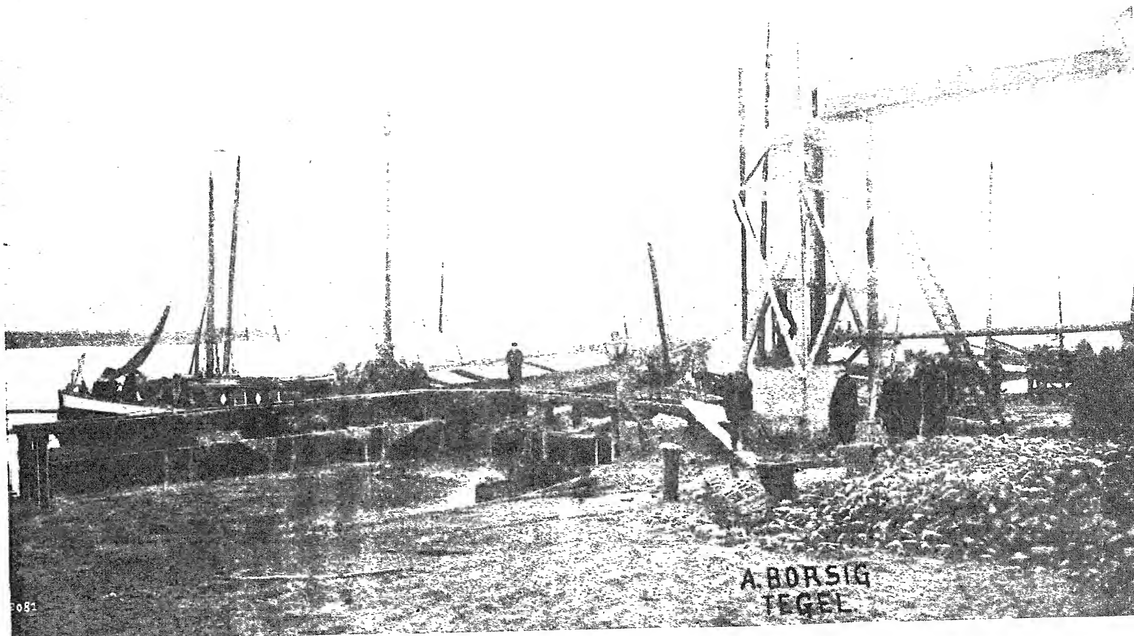


Fig. 3.

Mammoth Pump Unloading at River Side.

For raising clean water, and water alone, the mammoth pump has been known for about 15 years. About five years ago, however, the well-known firm of A. Borsig, of Tegel, near Berlin, made successful experiments in the raising of beets by means of this pump.

As the illustration shows, the pump consists mainly of a syphon tube into which the mixture, consisting of the float water and beets, runs from the float channel. At a suitable depth a foot piece is inserted in the rising part of the tube through which the compressed air required for its operation is admitted. The compressed air is supplied by a compressor which can be driven either by shafting or by means of an electric motor or by direct coupled steam engine; it can be located at any point in the factory. The beets with the water are raised into a delivery channel through which they reach the washer proper. In the delivery channel a water separator or stone catcher can be built as desired.

In the run-off pipe connecting up with this stone catcher a shut off slide can be arranged so that it is possible to drop the beets into the washer, either dry or with as much float water as desired. The mammoth pump can be used for raising the beet from float-channel to float-channel, or from the latter direct into the washer, as shown in *Fig. 1.* Difference of ground level in plants under construction may be easily compensated by interposing mammoth pumps in the channels. Furthermore, a greater declivity is thus obtained for the several parts of the channels, without the necessity of placing the end too far beneath the ground. This means of conveyance of the beet offers a number of advantages as compared with raising them by means of chain pumps. In chain pumps the wear is very great, particularly on the gear wheels, so that the cost of upkeep is considerable; this item is entirely eliminated with the so called mammoth pumps. By this means of conveyance no movable parts whatever are subjected to any considerable wear by contact with the mixture to be conveyed. Moreover, this pump does not narrow at any point from the admission of the material until its discharge. For this reason breakdowns and stoppages are practically out of the question.

A special advantage of the mammoth pump is the very thorough washing given to the beets without injury to them, as proved in practice, the breaking off of stumps and other damage to the beets being prevented. From a constructional point of view this new means also presents advantages as compared with chain pumps and worm conveyors hitherto used. Further, with chain pumps of large capacity the superstructure above the ground, and also the foundation work are very extensive indeed, whilst the mammoth pump occupies a relatively small space, as there is, for instance, only one pipe above the ground as seen in *Fig. 1.* In some cases it has been found possible to replace two chain pumps, one of which lifted the beet and the other the float water, by one mammoth pump, the latter lifting not only

the beet but the float water at the same time to such a height that the latter was able to run to the settling basin by means of gravity. It is evident that in such cases the prime cost is far lower than with a chain pump.

Fig. 2 shows the outflow end of a mammoth pump supplied to the Culmsee Sugar Factory. With this pump the waste water of the factory is conveyed to a filter bed at the rate of 20,000 litres per minute, with a head of about 8 metres. For the production of the necessary compressed air a compressor is erected in the factory several hundred metres away and driven direct by steam engine.

Fig. 3 illustrates an interesting application of a mammoth pump plant at the water side of a large sugar factory in Holland.

This plant serves the purpose of lifting the beets into a channel as they arrive by boat for the sugar factory "de Klingelbeek," in Arnheim (Holland), the height of the channel being such that the beets, together with the float water, run by means of gravity to the factory, about 200 metres from the river. The beet is first of all raised from the ship into a float-channel which conveys it to the mammoth pump. At the beginning of the float-channel a slide is fitted through which the necessary float water automatically flows in from the river. In order to adapt itself to the rise and fall of the river level, the syphon tube is made telescopic in design.

The compressor driving the mammoth pump conveying the beet is of such dimensions that it can supply compressed air for a second mammoth pump for raising the remaining water required by the factory from a well which is connected with the river Rhine.

A CHEMICAL STUDY OF CANE SEED.

By Wm. E. Cross and W. G. Taggart.

I.

The sugar cane plant (*Saccharum officinarum*) does not as a rule produce seed in this country, the season in Louisiana and Texas being too short, owing to the frosts of winter, to allow the cane to reach its full maturity. In tropical regions, however, the cane produces "tassels" of seed after about 18 months' growth. It was long thought that this seed, if it were seed, was sterile, but experiments instituted by Harrison and Bovell in Barbados, and later by others, conclusively proved that the seed obtained from the tassels is capable of germination under proper conditions. Many attempts to grow cane from seed in Louisiana were, however, abortive until in 1906 success was achieved, a small crop of young plants being obtained from imported seed planted under special conditions.*

*Cf. Bulletin 127 (Agee, H. P.) Louisiana.

Cane seed has attained an enormous importance in the sugar world because of its use in the propagation of new varieties. Canes grown from seed do not come up true to type, but the seedlings from the seed of a cane show great differences in character with the mother cane, and with each other. Hence it is possible to produce an almost infinite number of new strains of cane by propagation from seed and by selection among these new strains better varieties than those ordinarily under cultivation can be obtained. The success that has been achieved along these lines has been striking; as the fact that the best canes cultivated in Louisiana, Hawaii, and Java are strains which have been obtained by propagation and selection of seedlings would indicate.*

Cane seed when removed from the tassel is found to be very small in size and protected by fairly long, white hairs. We could not find any report of investigations of this seed in the literature, except an analysis of one variety by Browne,† and it was therefore resolved to subject them to chemical examination.

Owing to the very small size of the seed it was impossible to separate the husk from the kernel, or in fact to remove the protective hair. The seeds were, however, separated with care from the stalks of the tassels upon which they grew.

In the first place, several varieties of cane seed were analyzed and gave the following results:—

	Antigua.	T105.	Lahaina.	Hawaii 29.	Barbados 306.
Protein	6·23	8·38	7·44	8·64	6·13
Fat	1·98	1·99	1·64	1·95	1·72
Pentosan	25·72	29·75	23·00	25·10	24·34
Sol. Carbohydrate	1·23	1·03	0·64	0·66	1·41
Lignin	12·71	12·78	21·57	16·04	22·09
Fibre	27·16	28·87	27·17	25·73	25·55
Ash	14·22	6·20	7·01	10·58	7·48
Water	10·75	11·00	11·53	11·30	11·28

The variation in ash content in the seeds from different sources was of much interest. The considerable variation of the lignin and soluble carbohydrate content of the different seeds was noticeable, but it is probable that this can be accounted for at least partially by the relative degree of maturity of the samples.

A special examination was made of the carbohydrates of the seed. The investigation of the *water soluble* carbohydrates, which it will be seen above were found to the extent of about one per cent. in the seed, showed the presence of reducing sugars, and glucose was identified in the extracts obtained.

Special tests for cane sugar by the method of E. Schultze‡ were carried out, but in spite of much effort no sucrose could be found. These experiments were made with different seeds, from Trinidad,

* Cf. Bulletin 127 (Agee, H.P.) Louisiana.

† Bulletin 91, Louisiana Experiment Station.

‡ Zeit. fur. Physiol. Chem. LII. 404.

Barbados, and Hawaii. These results are interesting in the light of the work of E. Schultze*, who states as the result of an examination of a large variety of different seed, that sucrose is a usual constituent of seeds, while reducing sugar is generally absent. However, it is possible that fresh seed might have given different results: the seed we worked upon, which has necessarily been imported from the tropics, and was somewhat old might have suffered enzymeic changes resulting in the inversion of the sucrose.

A study of the insoluble carbohydrates was then carried out. After washing with cold water, 60 grms. of seed from Trinidad was treated with two litres of 5 per cent. NaOH, in boiling water for one hour, and the extract pressed from the residue, which was then washed many times with cold water. The residue was again treated with 5 per cent. NaOH solution and the extract filtered off as before, the final residue being washed with hot water and then alcohol. This residue consisted of impure cellulose, which was of a light brown colour. The hemicellulose obtained was precipitated by acidified alcohol and after purification hydrolyzed. The hydrolysis was accomplished by heating up 25 grms. of the hemicellulose gum with one litre 2 per cent. H_2SO_4 for four hours at 120°C. The liquid thus obtained was pressed out from the residue, neutralized and evaporated to a syrup. The syrup was extracted with 80 per cent. alcohol, and the alcoholic solution evaporated to a syrup. Repeated purification of this nature gave a small quantity of light coloured syrup which was allowed to crystallize.

It may be remarked that the hemicellulose and the hydrolytic extracts obtained therefrom gave a very marked Absatz reaction,† indicating the presence of pentoses.

After standing some weeks, the syrup had become very completely crystallized out. The mass was dried on a porous plate, and recrystallized several times from water and alcohol, until a white crystalline sugar was obtained. This was subjected to qualitative tests for arabinose and xylose, but only the latter sugar could be identified with certainty, although traces of arabinose seemed indicated. Polarization of the purified product gave $[\alpha]_D = +19{\cdot}1°$ confirming the evidence obtained by qualitative tests that the sugar was almost pure xylose.

It was not found possible to identify galactose in the sugar obtained nor in the gum itself. A more thorough search for this sugar was made by boiling 56 grms. cane seed with 600 grms. 3 per cent. H_2SO_4 for four hours, oxidizing the syrup obtained by neutralizing and concentrating this extract. The oxidation for mucic acid was brought about by heating the syrup with nitric acid (Sp. Gr. 1·15) in the usual way, but no mucic acid was obtained, the insoluble precipitate being entirely inorganic in nature.

---

* Zeit. fur. Physiol. Chem. LXI. 284-285.

† B. Tollens. Ber. 29. 1202.

Methyl pentosan was not present in any kind of cane seed examined. Quantitative tests by the method of Tollens & Ellet* gave negative results.

The cellulose was next examined. The crude fibre, after twice extracting with alkali, was dissolved by means of sulphuric acid according to Fleshig's † method, and by neutralization and evaporation of the extract a syrup was obtained, which was purified in the usual way. No trace of *mannose* could be discovered: the phenylhydrazon test in many trials gave negative results. The presence of glucose, on the other hand, was readily established, showing the cellulose of the seed to be ordinary glucocellulose.

Lignin was identified in all the kinds of cane seed at our disposal by the pink colour produced by the action of a mixture of concentrated HCl and phloroglucinol. An interesting fact, however, is that the hairs which protect the seed are free from lignin. This may be easily shown by immersing some cane seed in some phloroglucinol—HCl solution, when the seeds themselves attain the pink colour while the hairs remain perfectly white.

Further work will be directed toward the investigation of the non-carbohydrates of the seed.

Summary.

Complete analyses of cane seed from different countries were carried out, and this work followed up by an investigation of the carbohydrates of the seed. The cellulose was found to consist of gluco-cellulose, manno-cellulose being absent. Preparation and hydrolysis of the hemi-cellulose showed xylose to be the main product of hydrolysis, arabinose being perhaps produced in traces; galactose could not be identified.

The soluble carbohydrates consisted of reducing sugar, mainly glucose; cane sugar could not be identified.

Lignin was present in considerable quantity in the seeds, but absent in the protective hair.

Sugar Experiment Station,
New Orleans, La.

It is interesting to set on record that some barley now growing on land in Suffolk, which last year was under sugar beet cultivation, is promising an excellent yield, thus showing that the cultivation of sugar beet improves the soil for other crops.

---

* B. Tollens & Ellet, Zeit. Ver. Zuckerind, *55*, 19.

† Zeit. für Physiol. Chem. VII., 536.

‖ The fibre still contained notable quantities of pentosan, as shown by the Absatz reaction and quantitative tests. This seemed difficult to remove from the fibre, but it was not possible to show that it differed in composition from the pentosan extracted.

THE SUGAR INDUSTRY IN FORMOSA.

By G. Horsin-Déon.

The native manufacture of cane sugar has existed for many years in Formosa. It was introduced by Malayan tribes who now inhabit the central and woody region of the island, which people are still called savages. Up to the present time they have refused to accept Japanese rule, and reject both the taxes and the officers who collect them, whose heads they systematically cut off when they fall into their hands.

The manufacture of sugar by these natives consists in crushing the cane between two vertical earthenware grindstones worked by buffaloes. The juice when extracted is carried by a gutter into a hut, in the interior of which are six or eight tanks of very thin cast-iron, one-sixteenth of an inch thick, and containing from six to nine gallons. These tanks are arranged with a wooden paddle for the scum. They are placed side by side and are heated directly by fire with bagasse or wood as fuel. The juice is continuously passed by means of a ladle from one tank to the other, as it is concentrated, the last tank always receiving fresh juice. When the syrup attains a consistency, such that when a wooden stick is dipped into it and then plunged immediately into cold water a hard and brittle ball is formed, the syrup is poured on to a wooden table to set and cool, being gently stirred with a paddle. At the end of about fifteen minutes this product is removed when it is easily reduced to a pale crystallized powder, which is consumed by the Chinese, and is sold at about $1\frac{3}{4}$d. per pound, duties included.

There are over two hundred mills similar to this, generally worked by the Chinese who, now very numerous, have gradually settled in the island.

When the Japanese took possession of Formosa they intended to have a share in the riches of the country, and to give concessions of land for modern sugar factories. They divided into cantons or districts the parts of the island best suited for cane growing (without troubling themselves as to whether buffalo mills existed there or not), and these districts were distributed to the companies who asked for them, on the condition that they should manufacture granulated sugar there, the canes cultivated by the owners of the fields going only to the factory installed by consent of the government in this district. In fact, the tax on what is called "Chinese sugar" never exceeds $\frac{1}{2}$d. per pound, while the tax on granulated or centrifugalled sugar follows a scale varying with the colour of the sugar produced, according to the Dutch standard. This tax is 0·285 pence per pound for sugars from the third jets which are absolutely black, and goes up to 1·75 pence per pound for extra white sugar. No analysis is made

of these sugars. The Japanese Government, moreover, compels the manufacturer to make the brown sugar as pale as possible, since the tax on this sugar is higher, and many overtures are necessary when a factory wishes to make sugar of a different colour from that indicated in the Government authorization which has been granted to it. These sugars then go to Japan where very large refineries are installed which, in consequence of the bankruptcy of the Japanese Sugar Trust three years ago, have now the control and the guarantee of the Government.

Up to the present, Japan has been obliged to turn to Europe, to America, to the Philippines, and particularly to Java for the sugar she consumes. But since Formosa has been making sugar, Japan's demand on these countries has diminished, and in about two or three years' time we shall see Formosa furnishing not only all the sugar that Japan needs for her own consumption, but producing a surplus, which, refined in Japan or Hong-Kong, will be sent to Manchuria, Corea, and China.

The cheapness of manual labour in Formosa makes it possible to compete with the other imported sugars.

It also seems that Japan, which has already established several monopolies, will consider the establishment of a sugar monopoly, but first of all she must encourage the cultivation of the sugar cane in Formosa by making canals for irrigation and roads for cartage. Up to the present time nearly the whole of the money received in Formosa from these taxes goes, they say, to Japan. They have already begun to enlarge the port of Takow, where all the material for the sugar factories arrives, and from whence they ship nearly all the sugar, but for this the inhabitants have to pay a special and supplementary contribution besides the actual taxes.

In order to assist the cultivator, who is exclusively of the Chinese race, a system of canals is necessary to irrigate his lands, which he is now obliged to water by hand in the most primitive fashion. It will be necessary for him to have suitable roads for his cartage, which at present is done partly on men's backs and partly in rustic carts, and thus to enable him to carry the chemical manures which his lands will need after the forced cultivation of late years. The sugar factories have indeed established in their respective districts a network of little narrow-gauge railroads, the traction being done by machinery, men or animals; but even this is not sufficient, since these districts are not connected and the roads do not pass through the villages. They must do better than this, unless they wish to see the produce of the sugar cane diminish, especially since they only get two crops from the same cane; that is to say that the plants are renewed every two years.

The Japanese Government has, however, established at Daimoku a school of agriculture with enormous gardens for experimenting principally for the cultivation of the sugar cane and also of the

cotton plant, which they wish to introduce into Formosa; the produce of tobacco and tea is likewise studied there, as they wish to see a greater production than these plants are at present giving. Professors have been sent from this school to study the systems employed in America, Hawaii, and particularly in Java; and the selection made in these excellently managed gardens will enable them to determine the canes and the methods of cultivation best suited for Formosa.

The modern sugar factories installed in the island have been built in England, Germany, and America. They are particularly well fitted up, although only brown sugar is made. The only apparatus to be found which are of French origin are evaporating plants of the Kestner type, together with their pumps and accessories. As these apparatus do not work according to the principles previously adopted up to now in both cane and beet sugar countries, we think it would be interesting to go into this subject in detail, as the object of our journey to Formosa was the starting up of various Kestner apparatus.

Messrs. Bain & Co. originally obtained concessions from the Japanese Government, and erected three factories, one for 400 tons of cane per 24 hours at San-Kan-Ten, the second for 200 tons at Ho-Zan (both making centrifugalled sugar), and the third for 80 tons at Po-Ta-U, to make Chinese sugar only but utilizing steam for operating the plant and for heating. Having obtained an increase in its concessions, this company in the second year was obliged to increase the first factory to 850 tons, the second to 400 tons, and the third to 120 tons, and this increase had to be met with but little expense, because of the fear of the sugar monopoly. Moreover, as they only shut down for six months, from June to December, between the two crops, they could not thoroughly overhaul the factories, especially as it is impossible to procure locally the wrought or cast-iron material, which has to be obtained from Europe. In order to economize vacuum pump, condensers, and distilled water pumps, the problem was placed before Mr. Kestner of evaporating the juice in multiple effects under pressure, using exhaust steam from a mill engine working at the necessary back-pressure, which would enable them to obtain a considerable economy.

In the first factory at San-Kan-Ten (*Fig. 1*) they therefore erected a triple effect working by exhaust steam from the second mill engine at 42 pounds per square inch (140° C.), the last shell of this triple effect producing steam at 110° C. (7½ pounds per square inch) heating the existing triple effect working under vacuum. These two evaporating apparatus, the Kestner triple effect under pressure, and the ordinary triple effect under vacuum, could either work separately and concentrate 3080 gallons of juice per hour each up to 28-30 Baumé, or work in sextuple effect for 6160 gallons of juice. This latter method had the advantage of giving juice partially concentrated

and very hot to the first shell of the second triple effect which could then do without a heater. The first method, also cut out a heater for the syrup, for as the syrup coming from the Kestner was at a tem-

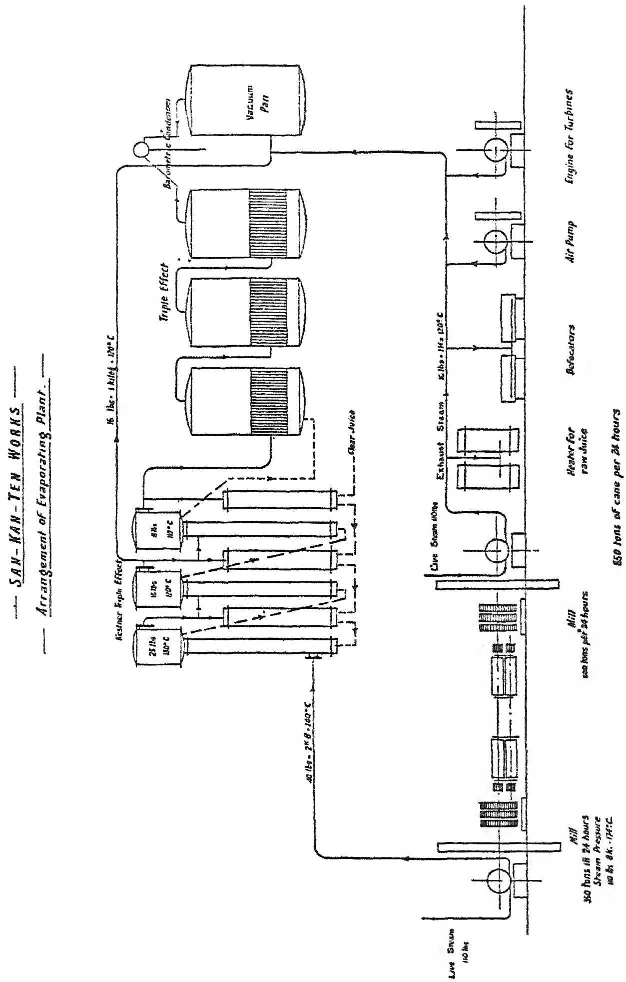


FIG. 1.

perature of nearly 100°, the mixture of the two syrups coming from the Kestner triple effect and the triple effect under vacuum was at the temperature required for passing into the vacuum pans. The exhaust from the engine (*B*) of the first mill at 15 pounds per square

inch, back-pressure together with the exhaust from the pumps (E) and the engine of the turbines (F) effected all further heating, that is to say for the raw juice (C) and the defecation (D).

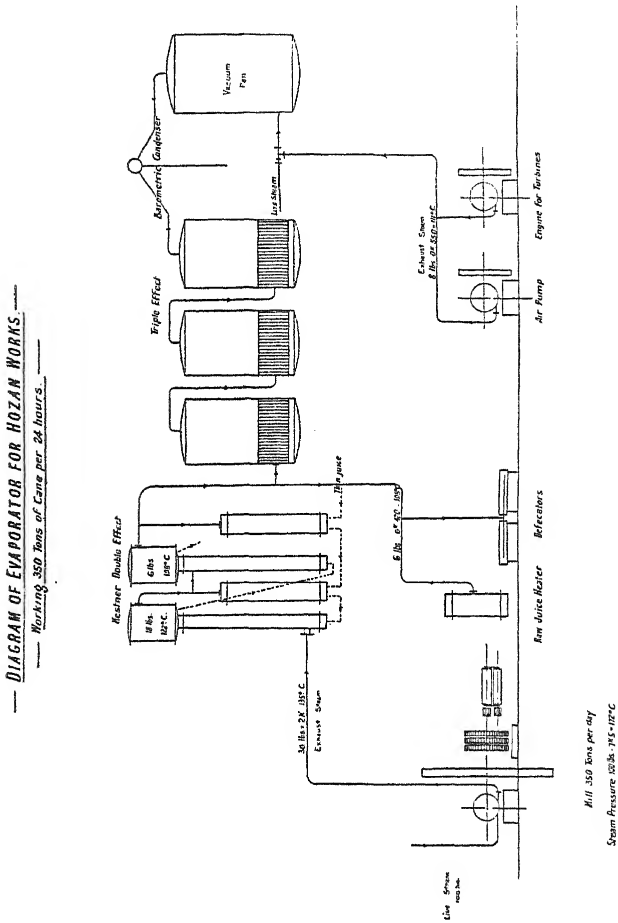


FIG. 2.

In the second factory Hozan (*Fig. 2*) they erected only a double effect Kestner. There was only one mill engine (A), which was not able to work at a very high pressure, this apparatus was therefore heated by exhaust steam at 135° C., 30 pounds per square inch; the second shell providing steam for the raw juice heater, the defecators (C), and the existing triple effect under vacuum. The vacuum pans

used the exhaust from the pumps (*D*), the turbine engine (*E*), together with a small quantity of live steam.

The first point that was observed in these two installations was that no supplementary fuel was required in addition to the bagasse, although prior to this the bagasse had not been sufficient to produce the necessary steam. Sometimes there was even found an excess of bagasse so that it had to be carted away. This excess enabled them to operate one half of the works during the time of washing out and cleaning down the other half.

In spite of the high temperature at which the juice was concentrated, there was never any alteration of any kind found in the syrup, while a good brown sugar of 96° polarization was obtained.

The Chinese workers considered that it was much easier to operate the Kestner, and that they were simpler than the ordinary pans in triple effect under vacuum, because in the latter case they had the additional work of regulating the cocks between the shells.

In order to provide against the reduction in the pressure of the exhaust steam from the mill, when at times it was necessary to stop the mill because of choking in the rolls or in the elevators, a reducing valve was fixed on the steam receiver so as to regulate the pressure on the Kestner which worked when the pressure fell in the receiver.

At the San-Ken-Ten works we discovered during the crop that in order to work efficiently, it would have been necessary to use a larger heating surface than those we had arranged for, which were based on beet sugar practice. Because of the impurity of the juice in this factory, where the defecation and decantation were entirely neglected, more often than not the juice which should have been carried to boiling point in the defecators only reached the temperature when in the first shell of the Kestner, and this explains the increased purity found at the outlet of the triple effect under pressure.

For the 1911 crop the evaporator plant in the San-Ken-Ten factory was therefore completed by increasing the surface of the Kestner triple effect by the addition of a supplementary shell which was used as the first shell, the old first shell and the second being used together as a second shell. This enabled them to take the necessary vapour from these second shells, and this, augmented by the exhaust from the second mill, the pumps and the turbine engine, was sufficient to heat the vacuum pans. This is shown on the drawing, *Fig. 1.* This was found to be a very economical charge.

In the third factory of Po-Ta-U a Kestner falling film shell, heated by live steam, was added, the exhaust from the mill being used for the raw juice heater and the defecators. All the juice produced passes through the Kestner and is delivered partially concentrated into two tubular "Aspinall" pans heated by exhaust from the Kestner shell, where the concentration is continued. The syrup collected in these "Aspinalls" passes from the Kestner into open pans, where it

is taken to the exact point for pouring on the tables for producing Chinese sugar.

They were therefore working in double effect with the Kestner as the first shell and the "Aspinall" as the second shell.

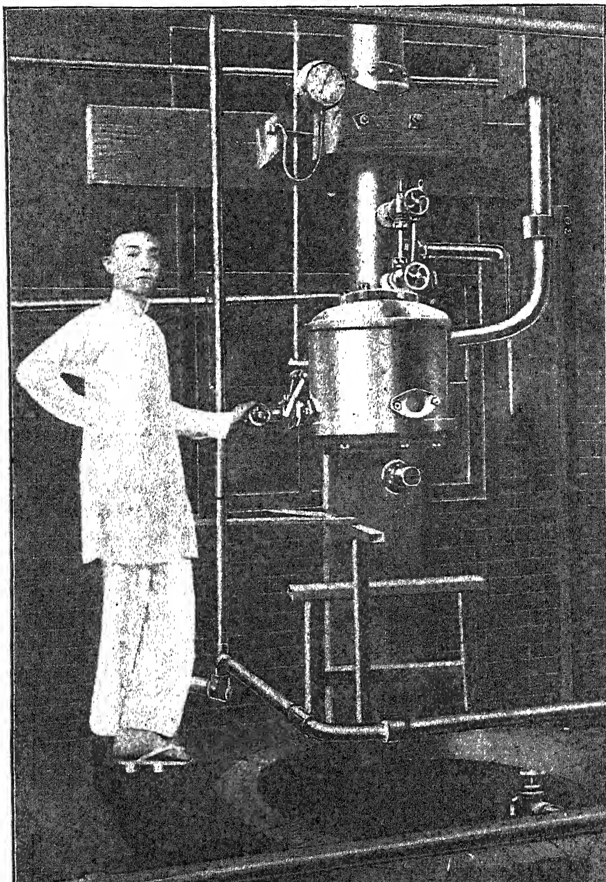


Fig. 3.

Manufacture of Chinese Sugar.

At the beginning of the manufacture some very interesting tests were made in the first two factories for working the mother liquor from the centrifugals (in manufacturing Chinese sugar) with a falling film Kestner shell (*Fig. 3*), and owing to the results obtained they

stopped in the middle of the manufacture the working of the vacuum pans, the second jets, and the malaxeurs, in order to replace them by the following process.

In a falling film Kestner shell the molasses from the first jet centrifugal was concentrated in a single passage up to about 3 per cent. of water. This molasses was discharged direct from the centrifugals into a tank which was situated on the ground level below the apparatus, and from which the Kestner feed pump takes it, and feeds it first through the heater and then into the Kestner evaporator, the heater being heated by the exhaust vapour from the Kestner.

Either coolies or Chinamen hold some wooden receptacles, about 5 feet 9 inches long by 2 feet 9 inches wide, into which the concentrated liquor runs from the outlet of the Kestner separator, this being a similar method to that adopted in the native manufacture of Chinese sugar. When there is a layer of 1½ to 2 inches in the receptacle, they bring forward the next one, and so on, without stopping the apparatus. These receptacles are then laid side by side on the ground and other coolies stir the concentrated liquor in them, first with an implement shaped like a croquet mallet, then afterwards with a small instrument somewhat resembling a garden rake. This concentrated liquor immediately crystallizes on cooling (in 15 to 20 minutes), and depending on the content of glucose in this liquor, it can be reduced either to a powder similar to the Chinese sugar but darker—because it is obtained by boiling the molasses instead of syrup—or left in lumps, or little thick blocks like nuts. This product is packed in baskets, from which is derived the name "basket sugar," made from split bamboo and lined inside with palm leaves; or else it is packed in white wood barrels in which they have received cement. For this last method of packing, the duty is only 6s. 9d. per 100 kilos., whereas in the baskets the duty is 10s. per 100 kilos. This sugar keeps dry for a long period, and is very much liked by the Chinese population, and even the Japanese now consume it in this condition.

The labour involved for an installation includes an engineer in charge of the pumps and evaporators, six coolies for carrying the receptacles, four coolies for stirring the sugar and one coolie for packing and weighing, together with one man for fastening up the packages. The molasses so treated is sold at 25s. 6d. to 34s. per 100 kilos. and allows a minimum profit of about 1s. 2d. per 100 kilos. in excess of the usual method of working, that is by vacuum pans, malaxeurs, centrifugals and molasses; the cost of carriage on the latter to the Japanese distilleries being both difficult and expensive because in addition to the cost of handling, the sun deteriorates the barrels and causes them to leak in the wagons and on the quays.

This process of treating the molasses from the centrifugals has the advantage of enabling the final molasses to be treated at the same time as the sugar, and could be adopted with advantage in several

countries where cane molasses has only been used up to the present, as fuel or artificial manure. Incorporated with the sugar it can be sent to refineries, where after being melted it is treated as third jet sugar, a large quantity of product turned out in Formosa being now dealt with in this way.

The two factories of San-Kan-Ten and Ho-Zan treated in this way all their molasses from the first jet, although they had already installed vacuum pans and the necessary malaxeurs. They have now on order a Kestner pan for the next crop which is of sufficient capacity to treat the molasses as it is discharged from the first jet centrifugal.

Owing to the cheapness of hand labour, which costs only 16s. per day of 24 hours for 28 workmen, they have not arranged for the mechanical operation of the receptacles into which the concentrated liquor is poured, but it would be quite easy to do this mechanically and dispense with the coolies.

For the next crop this company will erect some new works for the manufacture of Chinese sugar, direct from syrup by means of a Kestner. These works will be installed adjacent to the factory which manufactures the sugar from the centrifugals, in order to enable them to manufacture either the one or the other product according to the selling price of each of these sugars.

The method of manufacture for the Chinese sugar will therefore be as follows:—the exhaust from the mill will be discharged into a Kestner double-effect falling film evaporator producing syrup at 30° Bé., the exhaust from the last Kestner shell and from the pumps will be discharged into a heater for the raw mill juice and to the defecators. The juice after liming is raised to boiling point in this heater. The syrup after being discharged from the Kestner double-effect is delivered into a Kestner falling film evaporator where it is concentrated in one passage up to 2-3 per cent. of water and is rapidly cooled on the tables for producing Chinese sugar.

The other modern factories in Formosa chiefly belong to Japanese companies, only a few being held by Chinese. They work by the usual processes—mills, defecators, filters, vacuum pans for the first, second, and third jets, with malaxeurs for the by-products. Either European or American engineers superintend the erection and starting up of these works of which the directors, managers, workers, and chemists are all Japanese who have learnt what they know in America or in Hawaii. The pan-men are Chinese from Java, or else Japanese who have also learnt sugar boiling in Hawaii. It is remarkable what a keen intelligence and extraordinary power of assimilation the Japanese have. Their powers of observation are also highly developed and they have a great tenacity of purpose. They have not only succeeded in understanding and regulating these large plants used in the cane sugar industry, but in addition can also carry out all the

chemical work required in sugar houses. The profits obtained by the sugar manufacture in Formosa have enabled the manufacturers to experiment to a large extent without suffering any pecuniary loss.

When one visits a Japanese works they make it a point of honour to show you everything scrupulously clean, and exceptionally clear juice leaving the apparatus, even though they keep you waiting an hour in their very neat offices, entertaining you in the meantime with tea and cigarettes, while the cleaning operations are being carried out.

EFFECT OF FEED WATER CONTAINING SUGAR ON BOILERS.*

By Dr. F. P. Pillhardt.

In every rationally conducted sugar factory the hot condensation water is employed for feeding purposes, and thus it is not exceptional that sugar should be introduced into the boilers. It is true that all efforts are made to avoid this danger by carefully testing the boiler and feed waters, but these are not always successful.

Small amounts of sugar may be identified by the characteristic dark colour of the boiler water in the gauge glasses. On blowing off, strong foaming occurs, and the peculiar smell of burnt sugar is observed. Chemical testing of the water shows that in this case it has become acid through the decomposition products of sugar, whereas previously it had reacted strongly alkaline, owing to the ammonia given off during evaporation.

When these simple tests show that sugar is in the boiler, quick and certain means should be taken to prevent any harm by its action. With only a small sugar content, the amount of which can be ascertained by titrating the acids formed by the decomposition with N/10 soda and rosolic acid indicator, the boiler water should be partly blown out, and replaced with fresh water containing soda, leaving the contents of the boiler slightly acid. It should be noticed that too high a soda content causes strong foaming in the boiler, and that the most suitable alkalinity is one in which 100 c.c. of the water correspond to about 10 c.c. of N/10 acid. The acids are neutralized by the soda, and their corrosive action is therefore obviated.

Quite different is the action if larger amounts of sugar momentarily enter the boiler. This can be caused by a tube, rusted by long use, suddenly leaking, or by boiling over in the evaporation apparatus. On this account great care should be taken in replacing the tubes, and in "beading" their ends, while efforts should also be made to prevent entrainment during evaporation.

* Abridged translation from the *Centralblatt für die Zuckerindustrie.*

Very rapid darkening of the boiler water, strong foaming, and, in addition to the formation of soluble acid decomposition products, the precipitation of large amounts of amorphous carbon, are the signs to immediately put the boiler out of use, in order to avoid an inevitable catastrophe. If these signs remain unheeded then the carbon, the final product of the decomposition of sugar, forms an isolating layer on the fire tubes, preventing in this way the transference of heat. As a result, the strongly heated surface swells out here and there, owing to the inner pressure of the boiler. Quite a thin layer, of only 2-3 mm., suffices to cause this heating of the plate, and only by immediately raking out the fire can an explosion be avoided.

If the swellings on the tubes are not too great, on warming them to red heat, they may be quite satisfactorily replaced by means of hydraulic pressure. But if they have become large protuberances, this method is of no use, and only a new tube can make the boiler serviceable again. The writer has had the opportunity of seeing tubes damaged in both ways, and of being present at the work of repairing them. In the first case, the swelling could be removed without any trouble, so that the boiler could be worked under the same steam pressure as before, but always on the condition that the spot, still weak, should be protected from the fire by being covered with fire clay. With the large protuberance, however, all efforts to correct it were without result, and there was nothing left to do but to put in another tube.

How does this destructive action of sugar on the material of the boiler take place? Sugar itself does not attack iron, but only its decomposition products. These decomposition products may exert both physical and chemical effects, depending upon the amount of sugar entering the boiler. By far the more dangerous is the physical action, since in this case the destruction of the boiler material may occur in a much shorter time, and with more serious consequences. The physical action takes place as a result of the decomposition of the sugar, the carbon attaching itself to the tubes acting as a good isolator of heat, hindering the interchange of heat between fire and water, so that the boiler plate reaches red and finally white heat.

Respecting the chemical effect, if only traces of sugar enter the boiler, these through the long duration of heating become finally an active factor. Under the influence of high temperatures, cane sugar is first converted into invert sugar, and Maumené has shown it is possible to completely invert a very dilute solution of sucrose at 106°C. in 15-16 hours. After the formation of invert sugar, the rotation decreases, and browning indicates decomposition, which darkening in colour increases in intensity with the time of heating, being caused by the formation of caramel, as the phenylhydrazine hydrochloride reaction shows. In addition to these caramel substances, other

decomposition products, as carbon dioxide, and formic, acetic, levulinic and ulmic acids are formed, and lastly carbon, as the final decomposition product. These acids, and also the caramel, which acts as an acid, attack the boiler walls with considerable damage, owing to the length of time and the high temperature, but in spite of the low concentration. Obviously the action occurs most at those points which are hottest, viz., in the tubes.

As has already just been mentioned, not only have the acids a solvent action, but caramel has also. Caramel consists of a considerable number of complexes, whose components, such as caramelan, caramelen, and caramelin, are capable of acting as strong acids. Into this difficult field, Gélis has obtained a deep insight, and has established that these caramel compounds are to be regarded as dihydric acids. The formation of the iron-caramel compound is a complicated process, since iron and its oxides do not react upon aqueous caramel solutions. In *status nascendi*, however, caramel acts on the metals and oxides, forming the readily soluble iron-caramel compound. In this direction numerous experiments have been made, which show that the iron in these compounds occurs in the ferricferrous state. Gélis has found that the composition of these iron compounds is as follows:

Ferricferrocaramelan: $Fe_2O_3 . 3C_{12}H_{16}O_8 + 2FeO . C_{12}H_{16}O_8$
Ferricferrocaramelen: $Fe_2O_3 . 3C_{36}H_{48}O_{24} + 2FeO . C_{36}H_{48}O_{24}$
Ferricferrocaramelin: $Fe_2O_3 . 3C_{96}H_{98}O_{49} + 2FeO . C_{96}H_{98}O_{49}$

These compounds, and many others, occur together with carbon in the incrustation of a boiler fed with water containing sugar. Vivien has analysed such an incrustation with the following results:

Organic, and different volatile substances	6·640
Silica and silicates	4·600
Ferric oxide	88·500
Copper and lead	—
Sulphuric acid	0·103
Lime	traces
Potash	traces
Soda	0·157
	100·000

Soluble organic and inorganic substances were not determined. The organic acids had the appearance of caramel and ulmic acid, and therefore originated from the decomposition of sugar. In the figures of the analysis, the high content of iron is striking, and from this it is apparent that the caramel had acted upon the iron to a considerable extent. Vivien, therefore, carried out laboratory experiments to ascertain the action of hot sugar solutions on different kinds of iron, and arrived at the following results: Water containing caramelized sugar attacks both wrought iron and steel, especially the first, as the result of its acid properties; boiled de-ærated water attacks iron less readily than water containing air; a small ammonia alkalinity decreases the action on iron to a large extent.

In these experiments the action on the iron was much greater than really occurs in practice. The reason of this is that after a time iron oxide and inorganic salts form on the boiler surfaces, and protect the iron from the action of the acids, thus retarding the destruction. Claassen, for this reason, recommends feeding the boilers with ordinary water containing lime before the commencement of the campaign, so as to cause a thin layer of protective scale.

Interesting experiments in this direction have been carried out by Klein and Berg. They observed that sugar solutions, heated in contact with iron, soon became distinctly acid, acting on the iron with the evolution of hydrogen. Pieces of boiler plate were heated in a closed vessel tube to 115-120°C., and the amount of iron passing into solution, as well as the decrease in the weight of the piece of plate, were ascertained. It was found that the iron in solution was present as a salt of acetic acid. In a control experiment, the same iron was heated in distilled water under the same conditions, when, however, it was impossible to identify any iron in the solution.

Thus, in the course of the campaign with small sugar contents, the boiler material may become strongly corroded, so that harm may result after a time. Both steam supply pipes and fittings unfortunately suffer by the action of the caramel and other acid decomposition products. It is therefore apparent that no trouble and cost should be too great to prevent this danger.

THE BACTERIAL DETERIORATION OF SUGARS.

By Wm. L. Owen, B.S.,

Bacteriologist of the Agricultural Experiment Station of the Louisiana State University.

(Continued from page 324.)

Part III.

The Nature of the Bacterial Deterioration of Sugars and the Conditions Affecting this Action.

The results of experiments upon the deterioration of sugars as induced by pure culture inoculations, and as observed under natural conditions, would indicate that the action of the bacteria upon sugars is not that of a normal inversion.

Grieg Smith,* who first discovered the gum formed by the organisms occurring in sugar, and gave it the name of Levan, accredits the organism with the power of inverting sucrose. His theory is that the organisms first invert the sucrose, and from the nascent levulose and dextrose thus formed levan is produced. His ground for the nascent levulose and dextrose origin of the gum is that he was unable

* Proceedings of the Linnean Society of New South Wales, Vol. XXVI, Series I, p. 602.

to produce it from either of these sugars in their natural condition. He therefore holds to the opinion that the formation of gum is dependent upon certain properties peculiar to these sugars in their nascent stage. It is very evident, as we have already observed in our experiments upon sugars, that the formation of gum is intimately associated with the deterioration brought about by bacteria. We would scarcely suspect the conditions of the sugar to be favourable for the action of invertase, which, according to O'Sullivan and Tompson,* is inactive in any concentration of sucrose greater than 40 per cent.

Moreover, very few bacteria secrete the invertase enzyme. Fermi,† who has made a thorough investigation of this subject, has found that this power is possessed by very few bacteria, and these are only able to bring about a very weak inversion of sugars. The formation of levan in sugar was very strongly indictated in our results upon the inoculation of sugars. This action, according to Smith's theory, presupposes the inversion of sucrose as the initial stage of gum formation. According to this theory, the formation of gum is more of the nature of a by-product than the principal product of this bacterial action. If this were true, it would seem possible that there would be certain conditions in which sucrose would be destroyed by these micro-organisms without any gum formation. It seems likely, for example, that under certain conditions the inverting action of the organisms might be stimulated, while gum formation might be entirely suspended. If the two actions are distinct it does not seem improbable that the optimum conditions for each might be thus differentiated.

Influence of Concentration of Sucrose upon Gum Formation.

As one of the conditions affecting the action of invertase is the concentration of sucrose, we first investigated its influence upon the action of the bacterial species constituting the bacterial flora of sugars.

Using a medium containing 0·1 per cent. of peptone, 0·2 per cent. of sodium phosphate, and sucrose in proportions varying from 1 to 10 per cent., it was found in the case of *Bac. vulgatus* that in every case where sucrose had been destroyed levan had been formed, although the amount of gum shown by the analysis was not in every case proportionate to the amount of sucrose destroyed. In this connection, however, it must be remembered that the gum is to some extent transitory, owing to the fact that it is quite readily hydrolized by the acids formed in the course of fermentation. The experiment also showed that the greatest percentage of gum formed to sucrose destroyed was coincident with the presence of the largest percentage of reducing sugar to destroyed sucrose. It seems, therefore, that reducing sugars are not the origin of the gum, for otherwise we should find the largest ratio of gum to destroyed sucrose in the case where the ratio of reducing sugars to destroyed sucrose was lowest. Where we had the

* Journal of Chemical Society of London, Transactions, Vol. LVII., 1890, p. 834.
† Cent. Bakt., Vol. XII, 1892, pp. 713-715.

highest percentage of destroyed sucrose represented in the gum formed, we also had the largest percentage of reducing sugars, and, although the optical activity of the gum introduced an error into our Clerget determinations from which we made our comparisons, yet this error does not invalidate our comparative data. It was further seen that the concentration of sucrose most favourable for the development of gum seems to be about 20 per cent., whilst the largest percentage of gum formed to sucrose destroyed takes place at 25 per cent. In none of these various concentrations is there any suggestion of a typical inversion having taken place, and it was shown that the presence of the largest amount of reducing sugars is associated with the highest ratio between destroyed sucrose and gum development. It appears obvious that the formation of gum does not depend upon a previous inversion of the sucrose.

The Influence of Reducing Sugars on the Formation of Gum.

It was interesting to see to what extent the formation of gum is influenced by the presence of reducing sugars in the medium. The solution used was the same as in the previous experiment, except that reducing sugars in amounts varying from 2 to 10 per cent. were added, the culture again being *Bac. vulgatus*. It was then found that the greatest amount of gum was formed with 7 per cent. sucrose and more than 3 per cent. of reducing sugars, but that with 8·7 per cent. of reducing sugars, no gum was formed. Indeed the presence of reducing sugars seems to have little influence in gum formation, and the results of this experiment are only a repetition of the previous one, in which the concentration of the sucrose was the only variable factor. The variation of reducing sugars in the above experiment seems to affect the formation of gum only in so far as it has been accompanied by variations in the percentage of sucrose. If the gum was formed from reducing sugars it would seem that the increase of reducing sugars would have been followed by an increased amount of gum formed. In the above case the reducing sugars used were in the form of equal parts of dextrose and levulose, which were added to the solution.

The Influence of Dextrose and Levulose on Gum Formation.

On carrying out a similar experiment, but varying the proportions of dextrose and levulose, it was noted that the formation of gum is greatest where the sucrose is highest and decreases almost proportionately with the decrease of sucrose. The variation of dextrose and levulose had no effect and the gum varied just in proportion to the variation of sucrose. Unless there is some peculiar property possessed by these sugars in their nascent stage, as suggested by Smith's theory, which renders them capable of being transformed into gum levan, there is little evidence in the above experiment of the reducing sugar origin of the gum.

Influence of Acidity or Alkalinity upon Gum Formation.

As one of the accelerating factors in inversion by invertase is the acidity of the medium, it was of interest to carry out experiments in this direction.

It was in a slightly alkaline medium that the gum development was greatest, indicating that this action, unlike that of inversion, is favoured by slight alkalinity. Zopf* found this to be true of the formation of dextran by the *Leuconostoc mesenteroides*. This has been found to be true for the various gum-forming organisms described by other authors. O'Sullivan and Tompson† in their work on invertase found the optimum acidity varied according to the percentage of invertase in the solution and the temperature at which the inversion was conducted. Under no conditions, however, was inversion found to be stimulated by an alkaline medium. Fermi and Montesano‡ found that the inversion of sugar would take place to a very slight degree in a medium of slightly alkaline reaction. In this respect it was quite different from the invertase enzyme which is favoured by an acid reaction.

Influence of Peptone.

The bacteria inducing the gum fermentation of sucrose are somewhat unusual in respect to their nutrient requirements. They are able to develop upon a substratum which is very poor in nitrogen supply, and hence they are able to develop in sugars. As the nitrogenous matter in sugars would be subject to variations resulting from the different degrees of clarification, it might be interesting for us to investigate the influence of this substance on gum formation. Deerr and Norris have found in their work§ that bacteria were retarded in their development by the presence of more than very small amounts of peptone.

Using amounts of peptone from 0·01 to 1·0 per cent., and a control containing no peptone, the results as a whole did not tend to show any relation between the presence of peptone and the formation of gum.

Influence of Chlorides upon Gum Development.

In the work of Deerr and Norris on the deterioration of sugars, these authors observed that there was a more or less distinct relation between the inorganic constituents of a sugar and its tendency towards deterioration. Of this inorganic portion or mineral matter the chlorides were thought to be of most importance in their influence upon the keeping qualities of a sugar. Zopf,† in his work on *Leuconostoc mesenteroides* found that calcium chloride tended to accelerate the fermentation of sugar into dextran by this organism. On investigating the influence of chlorides upon gum formed by the species under investigation, so that we might determine its influence in sugars,

* Beit. z. Phys. und Morph. Niederer Organismes. Heft 1, 1892, p. 1.
† *Loc. cit.* ‡ Cent. Bakt. II., p. 482-542.
§ Bulletin No. 24, The Deterioration of Sugars in Storage, Hawaiian Sugar Planters' Association.

both calcium and potassium chloride were used in varying amounts, so that the experiment was not only a comparison of varying amounts of chloride but also a comparison of the relative influence of the two substances upon gum formation.

According to the results obtained, it seems that chlorides have little or no influence upon gum formation.

The Influence of Air upon Gum Formation.

The species constituting the bacterial flora of sugars are facultative anaerobic, but they would be expected to induce a more active fermentation of sugars under aerobic conditions. In order to determine the extent to which this action is dependent upon the air supply, experiments were carried out under (*a*) anaerobic, (*b*) natural, and (*c*) air-in-excess conditions, and results obtained showing that the condition of the aeration of a sugar may have a marked influence upon its deterioration. Everything else being equally favourable for the action of the gum formation, we might, in the light of the above experiment, expect a greater deterioration from a well-aerated sugar than where there was no circulation of air. This might, doubtless, explain why certain very low grade sugars do not deteriorate as rapidly as the higher grade sugars. The molasses comprising the film around the crystals may exclude the air, while in the higher grades of sugars there might be a copious supply. It has been observed by other investigators of this subject that the difference in the deterioration of a low and high grade sugar indicated that some condition obtained in the latter which made them deteriorate more rapidly. As the condition of moisture is a very vital one, and as this condition is apt to be more favourable for bacterial action in the lower than in the higher grade sugars, the relative aeration of the two products may be a possible explanation of the difference in the rate of deterioration. We have in many cases observed that where the moisture of a higher grade sugar happens to be increased from any cause until it approximates to that of an average raw sugar, a deterioration under such conditions is very rapid and very much greater than in low grade sugars of the same moisture content.

Gum Development as affected by Duration of Inoculation Period.

In some of the old culture solutions, in which the development of gum had been in progress for some time, it was observed that the gum in certain of these cases showed a tendency to decrease. This may probably be attributed to the hydrolytic action of the acids developed in the process of fermentation. In order to determine the relation between the age of the culture and the disappearance of the gum, as well as to study the rapidity of the destruction of sucrose, a large quantity of standard sucrose solution was inoculated with cultures of *Bac. vulgatus* and incubated at 37° C. An analysis was made before inoculation, and every other day thereafter for three weeks.

Results showed that the sucrose in the solution was completely destroyed by the tenth day, and that the analysis on the second day showed a concurrent development in both gum and reducing sugars. The amount of gum was highest on the sixth day, after which time it decreased up to the time of the analysis, made after 42 days.

Isolation of Gum-forming Enzymes.

In studying the formation of levan by the bacteria of sugars there is much to suggest extracellular enzyme action. Were the gum formed intracellularly it is believed that it could diffuse from the cell only with the greatest difficulty and if it originated extracellularly it seems that there would be little difficulty in demonstrating its presence as a capsule enveloping the organisms. But, as a matter of fact, the presence of a capsule was very rarely observed in our study of the species forming levan. Many efforts were made to demonstrate the presence of a capsule, and almost all of the special staining methods were used with little success. As most of these methods are based on the fixation of the capsule by acids, it was hardly to be expected that they would be effective in this case where the capsule, if present, would most likely be soluble in such a solution.

In order to determine the manner in which the gum was formed, an effort was made by the author to isolate the enzyme capable of producing levan from sugars. Believing that if there was such an enzyme it would very likely occur outside of the bacterial cells in solution undergoing gum fermentation and that it would be detected there at some stage of the fermentation period, the plan was to prove its existence by means of the porcelain filter.

The failure, however, to detect an enzyme by such means neither disproves the existence of the enzyme nor even the extracellular nature of its action. It is perfectly conceivable, of course, that an enzyme may be extracellular in its action and yet not filter through porcelain. There is, in fact, no relation between the zone of action of an enzyme and its behaviour towards the porcelain filter. Although all of the known enzymes which have been proven to be extracellular in their action have been demonstrated to be so by means of the porcelain filter, it, of course, does not affect the theory of an extracellular enzyme being non-filterable through porcelain. We next tried to isolate the enzyme from cultures on solid medium and for this purpose we used ordinary plain agar which was inoculated with *Bac. vulgatus* and plated out in large moist chambers, at 37·5 C. for a week or ten days. At the end of this time a vigorous growth had covered the entire surface of the chambers. This surface portion of the medium which was composed of the growth of the bacillus was scraped off with a sterile glass slide and placed in a large mortar, where it was triturated with powdered glass until it was of the consistency of a very finely ground mass. This large mass of the growth

of the organism was next dissolved in distilled water, after which it was precipitated into alcohol. The precipitate was then taken and introduced into a flask containing 250 c.c. of 10 per cent. standard sucrose solution, to which 25 per cent. of toluene was added to prevent the growth of any micro-organisms, and placed in an incubator at 37·5° C., where it was kept for several days.

Results were then advanced indicating that the enzyme isolated breaks down sucrose into gum and reducing sugar. In the light of this experiment and in further consideration of the preponderance of evidence that we have previously noted in support of this enzyme theory, it seems thoroughly consistent with the facts to state that gum levan is formed by an extracellular enzyme to which we give the name *Levanase.* The decomposition of sugars by this enzyme is probably as follows:—

$$C_{12}H_{22}O_{11} = C_6H_{12}O_6 + C_6H_{10}O_5.$$

As will be noted this reaction shows a new decomposition of sucrose. It is very probable that dextran is also produced by an enzyme*.

Part IV.

Practical Applications of the Results, and Conclusions.

Having previously shown in this report the nature of the bacterial deterioration of sugars, and having duly considered the characteristics of the species inducing this action, it might be of advantage to us to consider some practical aspects of the question as suggested by our previous experiments. As the deterioration of sugar is conclusively shown to be due to the action of this bacteria, it would be of some significance to discover the avenues through which such products become contaminated with these species. The seriousness of this loss would certainly warrant us in looking into the matter with the view of determining just how we may reduce the contamination through any possible modification of our present methods of manufacture. With this idea in view, certain experiments were instituted by this department during the season of 1909. These experiments were of the nature of a bacteriological control of the station sugar plant throughout the entire milling season. The purpose of the work was chiefly that of determining whether the contamination of the raw juices in the sugar manufacture resist the temperatures of the various processes during manufacture. It was first contemplated that the work would determine the different species peculiar to the different products of the mill. This work was carried on throughout the entire season during which time about ten "runs" were tested. It was

*The properties of this new enzyme are now being investigated and will form a subject of a publication that is to follow in the near future.

desired to have the results as representative of average conditions as was possible, and to this end every possible precaution was made to eliminate errors incident to accidental contamination. Sterile flasks were used in collecting all of the samples, and the plating of the various samples promptly followed the sampling, so as to eliminate the error of development of bacteria between the time of taking the sample and the subsequent plating. The samples were plated out upon sucrose agar, as this medium had been shown by special experiments to be more favourable to the development of the species than the ordinary plain agar. The syrups and massecuites were collected with great care and were usually taken just as they were made, and the sugars were táken directly from the centrifugal, and all possible chances of contamination were eliminated. Generally considered, the work was carried out with the least possible chance of error and the results, although in certain cases they show variations that are not easily explained, yet we could not expect absolutely consistent decreases in the organisms occurring in the different products. We may greatly reduce the number of organisms in the product in a certain stage of its manufacture, while subsequent exposures to the atmosphere might result in such a contamination as would show a slight increase over the previous product. The significance of the result, however, is not so much in the variation of the number of organisms in the various products, but it is that it is shown that in no stage of the manufacture is the product entirely free from micro-organisms.

Average of Results from Bacteriological Control Work at the Sugar House of the Experiment Station, Season 1909.

Nine "Runs."

Product.	Number of Organisms per grm. or c.c.	Species.	Presence of species of economic importance.
Raw juice	280,000	Yeasts, Moulds, Bacteria..	+
Sulphited juice	35,000	Yeasts, Moulds, Bacteria..	+
Limed juice ..	37,500	Bacteria predominating ..	+
Defecated juice	750	Sugar group Bacteria E..	+
Syrup	400	Sugar group Bacteria E..	+
Massecuite	450	Sugar group Bacteria E..	+
Sugars..	600	Sugar group Bacteria E..	+
Molasses	35,000	Mixture contaminated....	+
Wash water	25,000	Mixture contaminated ..	+
Filter-press cake	1,500,000	Mixture contaminated....	+

From the foregoing table it will be observed that the sugars as they are made are contaminated with the deteriorative type of bacteria which begin their work of destroying sucrose immediately, provided that the conditions of moisture are favourable. The resistance of the spores in these organisms, which we have found to withstand a temperature of 212° F. for two hours, renders it almost impossible to destroy them in the process of sugar manufacture. We may greatly reduce the number of them occurring in our products if we would practice cleanliness in our mills to the degree that science has taught us to apply to all of our food-manufacturing industries. Just as the keeping quality of milk and other dairy products is largely dependent upon the cleanliness of the conditions in which it is made, so the keeping of sugar likewise depends upon the conditions surrounding its manufacture. Referring to the table it will be observed that the defecation of the juice removes about 98 per cent. of the organisms occurring in the undefecated product. It is to this remaining 2 per cent. and its elimination that our attention should be directed. The use of antiseptic washes for the mills and tanks of the sugar house is to be strongly recommended. The drying of sugars is also to be recommended as a means of preventing this deterioration. In our experiments upon the influence of the acidity or alkalinity upon the gum formation, we found this action to be accelerated by a slight alkalinity of the media. In the sugar manufacturing industry we find opinion current that the deterioration of sugars is due to inversion by micro-organisms. This is no doubt one of the reasons why the refineries will work as far as possible with alkaline solutions. As our investigation has shown that the deterioration of sugars is not due to inversion, but to a gum fermentation which is favoured by slightly alkaline solution, it seems that modifications of this prevalent refining method might be well worth considering. So far as the deterioration of micro-organisms is concerned, there can be little doubt that the loss through inversion from this source would be small compared to that resulting from the action described in this report. In some cases where persistent heating is practised, the loss from inversion in an acid solution might be greater than that caused by micro-organisms in the same solution when alkaline. Lewton-Brain and Norris claim that no deterioration can take place in a sugar containing less than 1 per cent. of moisture. Our general experiments have tended to confirm their results.

An experiment of a similar nature to those conducted in connection with the operation of the sugar house has also been applied as a bacteriological control of a sugar refinery. The results of these experiments are also given in the following table :—

BACTERIOLOGICAL ANALYSES OF SAMPLES FROM A SUGAR REFINERY.

Name of Sample.	Dilution employed.	Number of organisms per grm. or c.c.	Presence of species of economic importance.
Raw sugar..	1·100	1,000	+
Raw washings	1·1000	5,000	+
Washed sugar	1·100	2,000	+
Melted washed sugar	..	..	..
Defecated washed sugar and liquor ..	1·200	800	+
Bag filtered washed sugar and liquor..	1·1000	3,000	Moulds and Bacteria.
Light sweet water	..	..	..
Clear filtered liquor..	1·1000	1,000	+
Defecated washings	1·000	6,000	+
Bag filter washings..	1·000	5,000	+
Dark sweet water..	1·2000	8,000	+
Char filter washings	1·400	8,000	+
Mud water	1·2000	400,000	+
Press cake	1·2000	No development	+
Press water	..	..	..
Concentrated sweet water	1·1000	20,000	+
Granulated magma	1·100	300	+
Granulated syrup	1·1000	5,000	+
Wet granulated sugar..	1·50	150	+
Dry granulated sugar	1·50	150	+
Remelted magma	1·50	200	+
Remelted syrup..	1·1000	25,000	+
Undefecated liquor	1·500	10,000	+
Remelted sugar..	1·500	500	+
Car sugar	1·500	3,000	+
Barrel syrup	1·100	8,000	+
Car syrup, two weeks in hot room....	1·100	400	+

From this table it will be observed, under the head of "The presence of species of economic importance," that such species were observed throughout the entire refining process. The title of this column applies generally to the species that cause the gum formation from sugar. The table of results in this case represents only one set of products. It is on this account of little value so far as the quantitative results are concerned. The qualitative analysis is very significant, however, since it shows that the gum-forming organisms

occur in all of the various stages of the process of sugar-refining, just as we have previously observed to obtain in the case of the manufacture of raw sugars.

SUMMARY OF CONCLUSIONS.

1. The deterioration of sugars is caused by a group of bacteria comprising the well-known potato group of bacilli.

2. The destruction of sucrose induced by these organisms is by means of an enzyme which we have termed *Levanase*. This enzyme is extracellular in its action and breaks down sucrose as follows:—

$$C_{12}H_{22}O_{11} = C_6H_{12}O_6 + C_6H_{10}O_5.$$

3. The formation of levan in sugars introduces an error in both the single polarization and Clerget methods of determination of sucrose. This error causes a decrease in the single polarization of 0·6° V for every 1 per cent. of levan, and an increase of 0·67° V for Clerget in the presence of 1 per cent. of gum. Owing to this error, a sugar in which gum formation has taken place would show an increase in sucrose by the Clerget method of determination.

4. The spores of the species causing deterioration of sugar are highly resistant to heat and survive different processes of manufacture, thus forming in part the contamination of the final products.

5. The gum formation of sucrose is favoured by a slightly alkaline reaction of the medium.

BRITISH GUIANA.

Yields of Sugar Cane from 1910 Crop.

(From *The Journal of the Board of Agriculture of British Guiana.*)

Reports were received from 25 plantations as to their crops of Bourbon canes. The returns varied from 1·08 to 2·43 tons of sugar per acre, the mean return working out at 1·66 tons. Twenty-one of the plantations reported on areas of more than 20 acres each, the extreme yields on them being the same as on all the plantations, but the mean yield was 1·60 tons of sugar per acre.

Thirty-one plantations reported their results with D 625, and of these 29 estates reaped areas of more than 20 acres each of that cane. The extremes over all areas were ·90 and 2·44 tons of sugar per acre, the mean being 1·77 tons. On the areas of over 20 acres each, the extremes were 1·28 and 2·44 tons, the mean working out at 1·80 tons.

Twenty-three plantations reaped D 145 cane, its mean return on all areas planted being 1·76 tons of sugar per acre, whilst the mean return on 15 plantations where areas of more than 20 acres each were reaped was 1·78 tons. On the first of these the extreme yields were

·84 and 2·32 tons per acre, whilst in the latter they were 1·12 and 2·19 tons.

Results were reported by 25 estates on B 208 cane, the extremes being ·95 and 2·30 tons of sugar per acre whilst the mean worked out at 1·70 tons. Fourteen of the plantations reaped areas of more than 20 acres each of these canes, the extreme yields reported by them being 1·39 and 2·18 tons, whilst the mean yield was 1·81 tons of cane per acre.

D 109 was reaped on 27 plantations, 24 of which had areas of over 20 acres of it. The maximum return recorded was 2·24 tons of sugar per acre, the minimum of all returns being ·61 tons, and those of large areas 1·15 tons. The means were 1·57 and 1·59 tons of sugar per acre, respectively.

Fifteen plantations had B 147 under cultivation, six out of which had each more than 20 acres of it. On all trials the extremes were ·80 tons and 2·64 tons, whilst on the larger areas they were 1·21 and 1·98 tons. The mean yields were 1·54 and 1·61 tons of sugar per acre respectively.

The White Transparent cane was cultivated on five plantations, four of which had areas greater than 20 acres of it. Its extreme yields were 1·24 and 1·77 tons of sugar per acre, its mean yield on all the plantations being 1·56 tons, whilst on those reaping more than 20 acres each of it, it was 1·65 tons.

B 376 was the only other cane reaped on several plantations. Thirteen plantations reported on its yields which varied from ·90 to 2·53 tons of sugar per acre. Three plantations reaped areas of more than 20 acres of it, the extreme yields being ·90 and 2·10 tons. The mean yield of all the areas was 1·57 tons of sugar per acre, that of the three plantations was 1·62 tons.

The areas reported on of each variety were:

	Acres.		Acres.
Bourbon	12,827	D 109	2,724
D 625	12,538	B 147	705
B 208..	8,378	White Transparent ..	303
D 145	3,317	B 376	170

Many varieties were reported upon, each of which had been reaped on a few acres only. The yields of the following were on areas of over 20 acres each:—

No. of Estates reporting.		Tons of Sugar per acre.	No. of Estates reporting.		Tons of Sugar per acre.
1	Diamond 399	2·44	2	Green Transparent.	2·24
1	Diamond 185 ..	2·31	1	D 74	2·23
2	D 4399	2·29			

Last year's experience confirmed earlier experience that certain of the new varieties, when cultivated over large and widely distributed areas, are capable of giving yields of 12 per cent. in excess of that of the Bourbon.

Areas of Varieties of Sugar Cane for Crops of 1911.

Reports have been received from 39 plantations which show that 37 plantations have 21,672 acres occupied by D 625, 32 plantations have 9531 acres of B 208, 31 plantations have 4382 acres of D 145, 32 have 3261 acres of D 109, 15 have 754 acres of B 147, 4 have 495 acres of Green Transparent, and 8 have 251 acres of White Transparent, whilst on 2 plantations 703 acres are occupied by Diamond 185.

The area occupied by D 625 is 5022 acres in excess of that under cane for 1910, an increase of 153 acres only is shown by D 145, and one of 216 acres by Diamond 185, whilst the following varieties show decreased areas:—

Variety.	Decrease. Acres.	Variety.	Decrease. Acres.
B 208	105	Green Transparent ..	89
D 109	802	White Transparent ..	106
B 147	342		

The following varieties are also being cultivated in areas of over 100 acres each:—

Variety.	Area. Acres.	Increase. Acres.
B 376 ..	194 ..	6
D 4399 ..	140 ..	27

45,385 acres are now occupied by canes other than the Bourbon, as compared with 41,004 during 1910, the increase being equal to 10·6 per cent.

The area occupied by the Bourbon cane has been reduced from 29,823 acres in 1910 to 24,252 acres for the crops of 1911. Thus 65 per cent. of the land on sugar estates which is cultivated in sugar cane is now occupied by varieties of sugar cane other than Bourbon.

J. B. H.
F. A. S.

CONSULAR REPORTS.

Holland.

The British Consul at Rotterdam writes:—

In 1910 the price of beet sugar rose from £1 3s. 4d. to £1 10s. per 100 kilos., and this was due to the general upward movement in the price of sugar in Europe, and consignments of sugar were received from Cuba and Java to counteract the action of dealers in beet sugar who were holding out to secure better prices.

The output in the Netherlands showed a diminution for 1910, in contrast to the increase in Germany and France, and the total of beet sugar produced was 194,818 tons; in 1909 the area of beet cultivation was 136,063 acres, and an increase on this figure will be found to have taken place in 1910 when the figures are made known.

In view of the experiments being made in the United Kingdom with the cultivation of beet for sugar producing purposes, it is of interest to remark that several ship loads of British-grown beet arrived at this port in 1910,

destined for inland tinned milk and sugar factories; the crop of Dutch beet not being equal to the demand, these factories have to look to another source of supply.

The cost of railway freight in the United Kingdom and the sea carriage to the Netherlands so enhance the final value of the beet that its importation into the Netherlands in normal times would not be feasible, and only when the factories are at their wits' end to find the supplies they require will they turn to the United Kingdom to make up the deficiency; whether further shipments will be ordered will also depend on the claim of the British beet on the market as a sugar-bearing root.

Corea.

As all sugar enters Corea on the same footing, it would be thought that Hong Kong and Java sugars would be able to compete with the Formosan product. Such is not the case, however, for, of the total import of 87,900 lbs., that from Japan amounted to 83,290 lbs. There is an increasing demand for sugar, especially used for cheap confectionery, and it is an unfortunate fact that the Hong Kong refineries have been unable to retain the large share in this trade which they had until a few years ago.

Java.

The British Consul reports as follows:—

The year 1910 has been a good one for sugar planters, both as regards production and price. The area under cultivation has been further increased and the weather in most parts of the cane growing districts has been favourable, with the result that the 1910 crop is estimated to be nearly 37,000 tons in excess of its predecessor. The whole crop was disposed of before the decline in sugar values occurred, the following prices (delivered in buyers' godowns) being obtained for the principal grades of sugar manufactured:—

	Price per Picul.	
	Fl.	Fl.
Muscovados—		
Nos. 10 to 15 Dutch standard	$6\frac{1}{2}$ to	8
No. 16 Dutch standard and above	$6\frac{3}{4}$	$8\frac{1}{8}$
Superior (white sugar)	$7\frac{3}{4}$	$9\frac{1}{8}$

British India is now by far the largest consumer of Java sugar, which has practically ousted all competitors in that market, and it is interesting to observe the facility with which the Java sugar industry has adapted itself to the special requirements of British Indian buyers. This is noticeable in the steadily increasing output of the higher grade sugars for direct consumption, the production of white sugars having increased from 70,000 tons in 1905 to 350,000 tons in 1910. Most sugar mills in Java have now adapted their plant to the production of white sugars, although they can revert with but little alteration to the manufacture of refinery sugars, should this at any time be necessary.

The latest official statistics show the production of the past three years to be as follows:—

		1908.	1909.	1910.
Planted area	Acres	289,744	301,134	312,000
Total production	Tons	1,241,885	1,241,726	1,280,300
Production per acre ..	,,	4·28	4·12	4·10
Mills working		177	181	182

Mr. Vice-Consul Dalrymple reports:—

"There was very little cane disease during the year, and the crop worked off much quicker than usual, although some mills were handicapped for a time owing to the cholera epidemic carrying off many of the cane cutters during the busiest period.

"The prospects for the coming crop are excellent, the weather up to the end of the year, excepting one or two districts, having been all that could be desired. The planted area, with 184 mills in working, is estimated at 325,150 acres, or about 4 per cent. more than 1910, so that with favourable weather conditions a record crop may be expected.

"About two-thirds of the crop has been sold at very remunerative rates, but as lower prices will probably have to be accepted for the balance, owing to the heavy slump in the price of sugar which occurred towards the end of the year, the coming crop can hardly prove as satisfactory financially as its predecessor. A considerable portion of the sugar sold is in the hands of Chinese speculators, who at the present moment stand to loose heavily owing to the decline in values, and some apprehension is felt as to their ability to face the loss when the season opens, and they have to take delivery of their purchases.

"With regard to the exports of sugar during the year, the most noteworthy features are the great increase in shipments to British India and the falling-off in the quantities exported to the United States and Australia. The United Kingdom and the Continent both show appreciable increases while China, Japan and British Columbia have all taken more than in 1909. As everything points to heavy crops in other sugar producing countries, it is probable that America, the United Kingdom and the Continent will require little Java sugar, while Formosa is expected to be able to supply the requirements of Japan.

"It therefore remains to be seen to what extent British India and China will be able to absorb the coming crop."

Mexico.

The British Consul in Vera Cruz has the following comments in the course of his 1910 Report:—

"I have often been told by leading dealers that they, as a rule, pay little or no attention to catalogues and other matter printed in foreign languages, especially where the weights and measures are not given in the metric system. In nearly every case the first question asked is, "What will the goods cost me delivered in Vera Cruz?" Another point of trifling importance, but which seems to cause more irritation than the loss of a considerable sum, is the failure to put more than a penny stamp on letters destined to Mexico, where the postage from the United Kingdom, as everyone should know, is 2½d. Quite a number of letters are received at this Consulate in the course of the year insufficiently franked, and I might even mention one instance when replying to an enquiry I returned the envelope in order to impress upon my correspondent the fact that I had to pay the overcharge, and although I received a letter of regret in reply, the said letter was also enclosed in an envelope with but a penny stamp on it. Apparently while this is a small point, I wish to say that it is hard, perhaps, to realise the irritation that this causes, especially as in this country correspondence when

insufficiently franked is held at the post office, and the person for whom it is destined is obliged to go to the post office, purchase the surcharge stamps, place them on the letter and obtain their cancellation before he can receive the correspondence, all of which means more or less loss of time either for clerks or messengers.

PUBLICATIONS RECEIVED.

Le Contrôle Chimique dans les Raffineries. By Ch. Toury. Series: Encyclopédie Scientifique des Aide-Mémoire. Published by Gauthiers-Villars, 55, Quai des Grands-Augustins, Paris. 1911. Price, 3 fr.

The first chapter of this new work is devoted to a review of the technology of sugar refining, but we regret to point out that the methods given in this part are representative more of the practice of at least 40 or 50 years ago than of the present time. It is actually stated, for example, that while re-melting the raw sugar a mixture of powdered animal charcoal and bullock's or sheep's blood is added for decolorization and coagulation, and also that beet sugars being alkaline, and cane sugars acid the two are mixed in such proportions as to give a neutral liquor in the blow-up. Only the old sugar loaf process, and a brief and inadequate description of the Steffen process, are given as representing modern refinery methods of manufacture, while the mode recorded for dealing with low products of the sugar house is quite out-of-date. In the next chapter, the general properties of the sugars are summarized, and this section is well written, although it is stated that top yeast converts raffinose into a mixture of levulose and lactose, and that sucrose has no action on Fehling's solution. Subsequent chapters form what the author understands by refinery control. Methods for finding the density of sugar solutions, and for determining sucrose, reducing sugars, ash, raffinose, acidity and alkalinity, and the *rendement* are given, while the full analysis of raw sugars, and the examination of substances used in refining, are finally discussed. In describing these methods, the author appears to have endeavoured to write for those unfamiliar with ordinary sugar analysis, and indeed he records the various details with great clearness. M. Toury should, however, have explained the significance of the true or metric and Mohr's cubic centimetre, if he mentions both, even though he prefers to adhere throughout to the temperature of 17·5°C. It is noticeable that more than 30 pages of the text are taken up by the old table of Scheibler. Only the Laurent polarimeter is described, and the old Clerget method is given, without mention of Herzfeld's improved procedure. It is stated that Gérard's formula is generally used for calculating the raffinose content. Animal charcoal is surely an article of importance in the refinery, but no details for its analysis are given.

It must be confessed that this, the first book devoted solely to the use of the refinery chemist, is very disappointing. It is entitled "Refinery Control," yet only a few methods of sugar analysis are described, without any attempt being made to indicate how these methods should actually be applied to the practical working of the sugar house. We should have expected M. Toury to show how the refining chemist is to search for the losses, known and unknown, that occur in the course of manufacture, and to give directions for the sampling of the various products. Perhaps also he might have given figures resulting from practical experience with the principal processes of making the various kinds of refined sugars on the market, recording, especially for the guidance of the young chemist for whom apparently he writes, typical analyses of the different liquors, syrups, and by-products at the different stages of manufacture.

ALCOHOLIC FERMENTATION. By Arthur Harden, F.R.S., Head of the Biochemical Department, Lister Institute, London. Series: Monographs on Biochemistry. VI. + 128 pp. Published by Longmans, Green & Co., London, New York, and Bombay. 1911. Price, 4s. net.

It was Moritz Traube who in 1858 enunciated the theory that all fermentations produced by living organisms, such as yeast, are to be attributed, not directly to the vital processes of the cell as a whole, but to ferments secreted by the organism. This view received the support and advocacy of such a great scientist as Berthelot, and also of Hoppe-Seyler and others. It was not, however, justified by direct experimental evidence, and for a time Pasteur's thesis, *no fermentation without life*, held the field. Very numerous were the attempts to effect fermentation apart from the living cell, by Pasteur himself, Marie von Manasseïn, Mayer, and others, most of these taking the direction of grinding, freezing, or plasmolyzing the yeast cells. Even extraction of the ground cells by glycerin or water, a method by which many ferments can be obtained in solution, was found by Nägeli and Loew in 1878 to give negative results. In 1898, however, the question, which had caused so much discussion and conjecture, and had given rise to so much experimental work, was conclusively settled by Eduard Buchner, who, by grinding with sand and kieselguhr, succeeded in preparing from yeast a liquid, the so-called "yeast juice," containing a ferment, Zymase, which, in the complete absence of cells, was capable of causing the phenomenon of fermentation, *i.e.*, of resolving sugar into alcohol and carbon dioxide.

In this book, the immense amount of valuable research which has been carried out in the new field opened up by Buchner's remarkable discovery is reviewed in the most interesting and lucid manner by Dr. Harden, himself perhaps the most eminent worker in this branch

of biochemistry. In very briefly summarizing the general conclusions that have so far been obtained in this direction, it may be pointed out that what may be termed the "mechanism of fermentation" is exceedingly complicated. It has been found, for example, that the enzyme Zymase, the ferment isolated by Buchner from yeast juice, which is essential for fermentation, cannot of itself bring about the conversion of sugar into alcohol and carbon dioxide, but is dependent upon the presence of a second substance, called in this book, for want of a more reasonable name, the Co-enzyme. What may be the exact nature and function of this mysterious coadjutor has so far not been determined, but it is known that its activity is not impaired even by heating to 100°C., and that it is dialysable. Not only is this co-enzyme necessary for the decomposition of sugar, but it has been established that phosphates also play an indispensable part, going through a remarkable cycle of changes. Thus it has been found that the breakdown of sugar into alcohol and carbon dioxide is accompanied by the formation of a complex hexosephosphate, and that the phosphate is split off from this compound, by means of a special enzyme, termed Hexosephosphatase and again rendered available for action. In addition to this complex of ferments, the cell also possesses special enzymes by which the zymase and the co-enzyme can be destroyed, and besides this there is at least one substance, known as an Anti-enzyme, which directly checks this destructive action. It seems probable, moreover, that the decomposition of the sugar molecule takes place in stages, although from the information given here it seems there is yet much doubt as to the nature of these.

ABSTRACTS, SCIENTIFIC AND TECHNICAL.*

HARLOFF'S "ACID THIN-JUICE" PROCESS OF MAKING WHITE SUGAR. *By J. J. Hazewinkel. Archief., 1911, 19, 123-139.*

According to the Harloff "acid thin-juice" process, cane juices are submitted to double carbonatation, then sulphured to acidity. Provided carbonatation is properly carried out, and the correct final alkalinity is observed, no calcium carbonate can be deposited, because the alkalinity of the carbonatated liquors is due, not to calcium, but to potassium or sodium salts, which remain in solution. When the author investigated this new method of working at the Boedoeran factory in Java, he found that it was carried out in the following manner:—In the first carbonatation, the maximum alkalinity at which the easy working of the presses can be operated is used, *i.e.*, 0·05 per cent. CaO, using phenolphthalein as indicator. The second carbonatation is effected continuously, using a temperature of 60-65°C.,

*These Abstracts are copyright, and must not be reproduced without permission.—(Ed. *I.S.J.*)

and is carried just so far that on testing neither carbonic acid gas nor boiling produces a precipitate. After this the juice is passed through the presses, the clear liquors sulphured, also continuously, this operation being carefully controlled by quantitative tests in the laboratory. Here sulphitation should be carried far enough to give well decolorized juices, but not continued to endanger loss by inversion, or corrosion of the boilers, as the result of feeding with water containing sulphurous acid. Generally, it may be said, it is stopped when 100 c.c. of the juice are neutralized by the addition of about 48 c.c. of N/100 soda, using the Vivien tube, with phenolphthalein as indicator, *i.e.*, when the SO_2 content is equal to approximately 150 mgrms. per litre. After evaporation the resulting syrup is filtered through Danek presses, at the temperature at which it runs from the effect, and immediately again sulphured, this time, however, very slightly. On graining, a very light massecuite is obtained, and the resulting sugar is especially good. Careful tests of the condenser water showed that only a slight acidity, with a very small sulphurous acid content, could be detected, and that there was little danger of corrosion of the boilers, or of the evaporators, from this source. It is, however, pointed out that if sulphuring of the juices or syrups were pushed to excess trouble might be experienced, even if the feed water were neutralized with sodium carbonate. During the course of the investigation, determinations of the thin-juices, syrups, and massecuites were made, but that no inversion occurred may be seen from the following average figures for the glucose ratio :—

Thin-juice.		Syrup.	Syrup.		Massecuite.
4·8	..	4·9	4·9	..	4·8
5·2	..	4·9	4·9	..	5·1
7·57	..	7·42	4·9	..	4·9

As advantages of the Harloff method of working, the author summarizes the following: (1) A better quality sugar is obtained, and all is recovered as a superior first. (2) Considerably improved boiling and crystallizing occurs, as the result of the decreased viscosity of the syrups. (3) Increased capacity of the centrifugals. (4) Economy in the cost of sulphur, as the result of the lessened sulphuring of the syrups, a decrease of 15 per cent. as compared with the old method being effected. (5) A more careful chemical control results, especially in the examination of the feed waters. (6) In the multiple effect, boiling is facilitated by the evolution of sulphurous acid gas, and gases from the decomposition of organic acids.

GRATE SURFACES FOR BAGASSE FURNACES. *By E. W. Kerr. Modern S. Planter*, 1911, 41, No. 41, 2-4.

In an article on this subject, it is pointed out that it is evident that the grate surface is dependent upon the rate of conbustion, which in

its turn varies according to the amount of moisture in the bagasse, the draught, and whether a blower is used. That the moisture content exerts an influence was shown in the author's experiment on bagasse drying during the past season (this *Jl.*, 1911, 163), when, with a draught of 0·1 in. of water in the furnace above the fire, tests showed an average combustion of about 62 lbs. of bagasse, containing 55 per cent. of moisture, per sq. ft. of grate per hour. With the same draught, but with a moisture content of 44 per cent., the rate of combustion was 54 lbs. Reducing both these sets of figures to terms of dry bagasse, the combustion per sq. ft. of grate per hour is found to be 28 for the bagasse with 55 per cent. of moisture, and 30 for that with 44 per cent. of moisture. As to the influence of the draught, a curve plotted from tests is given, showing that by changing the draught from 0·08 in. to 0·30 in. the rate of combustion was increased from 56 to 96 lbs. per sq. ft. of grate per hour. Dealing with forced draught, it is pointed out that with a blower and hollow blast bars much higher rates of combustion can be maintained than by natural means. Actual experiments indicated that with a pressure of 1·5 in. of water in the discharge pipe of the blower about 20 per cent. more bagasse could be burned than with vacuum draught only, the vacuum in the furnace being the same in both cases. Working with various furnaces, the author has obtained the following figures for the rates of combustion in forced draught plants.

Pressure of Air in Blower Discharge Pipe. Inches Water.	Vacuum in Furnace. Inches Water.	Moisture in Bagasse. Per cent.	Rate of Combustion. Lbs. per sq. ft. per hour.
7·5	·06	53	121
1·25	—	—	63
3·2	·07	50	147
2·7	·03	52	123
6·5	·04	52	88
6·2	·07	52	88
3·2	·02	52	130
4·0	·05	54	100
9·4	·12	—	102
3·9	.20	51	142
5·0	·22	52	149
Average—6·8	·09	52	114

Taking the average figures thus obtained, and an assumed equivalent evaporation of 2·25 lbs. of bagasse water per lb. of bagasse, we have 13·5 sq. ft. as the area necessary for a 100 H.P. boiler with 1·5 in. forced draught pressure. Thus it is seen that the grate area must vary considerably with varying conditions of the air supply. Assuming that the rate of combustion varies directly with the air pressure, and that 2·25 lbs. of water will be evaporated per lb. of bagasse, then

the relationship between air pressure, rate of combustion, and grate surface for a 100 H.P. boiler will be as follows :—

Blower Pressure in Inches of Water.	Bagasse burnt per sq. ft. Grate per hour.	Sq. ft. of Grate per 100 H.P.	Ratio H.P. to Grate Surface.
1·5	60	31	39
2·0	68·5	27·5	44
2·5	77	25	48
3·0	86·5	22	55
3·5	96	20	60
4·0	103·5	18·5	65
4·5	111	17·5	69
5·0	119	16	76
6·0	136	13	93

From other data obtained, the ratio between heating surface and grate surface, using natural draught, are shown in the following table:

Vacuum in Furnace. Inches of Water.	Bagasse burned per sq. ft. Grate per hour.	Sq. ft. of Grate, 100 H.P.	Ratio H.S. to G.S. H.R.T. Boiler.
·05	51	35·5	34
·10	62	31	39
·15	70	29	41
·20	80	27	45
·25	90	25·5	52
·30	97	25·5	52

With natural draught, a large excess of air, and therefore low economy, can only be avoided by making the vacuum in the furnace so small that little air will enter through the hoppers, even though they are open a large part of the time. The experience of the writer leads him to believe that it is practically impossible to design and operate hoppers in such a manner as to thoroughly exclude the air, and he is acquainted with most of the apparatus that has been and is used for that purpose. If such an arrangement could be devised, then higher rates of combustion could be used without high air excess, the result of which would be that smaller grates could be used. There is no doubt, other conditions being equal, that high rates of combustion and the accompanying small grates, are, as a general proposition, conducive to economy. Concluding, the author expresses the opinion that, for bagasse burning, such high rates are best carried out by means of forced draught.

Refractive Indices of Sugar Solutions. *By Otto Schönrock. Zeitsch. Ver. deut. Zuckerind., 1911, 421-425.* Compare this *Jl.*, Main, *1907, 481, 531;* Geerligs, *1908, 68;* Stanek, *1909, 82;* and also Tolman and Smith, *Jl. Amer. Chem. Soc., 1906, 1480.*

Acting on the instigation of the President of the International

Commission for Uniform Methods of Sugar Examination, Prof. Herzfeld, the author has determined the relationship between the refractive index, the water content, and the temperature of sucrose solutions, and in so doing has taken every care to obtain absolutely reliable results. In the following table, n is the refractive index (sodium light) at 20° C., and w the number of grms. of water in 100 grms. of sugar solution*:—

$n_{20°}$	w	$n_{20°}$	w	$n_{20°}$	w
1·3330 ..	100	1·3723 ..	75	1·4200 ..	50
1·3344 ..	99	1·3740 ..	74	1·4221 ..	49
1·3359 ..	98	1·3758 ..	73	1·4242 ..	48
1·3374 ..	97	1·3775 ..	72	1·4264 ..	47
1·3388 ..	96	1·3793 ..	71	1·4285 ..	46
1·3403 ..	95	1·3811 ..	70	1·4307 ..	45
1·3418 ..	94	1·3829 ..	69	1·4329 ..	44
1·3433 ..	93	1·3847 ..	68	1·4351 ..	43
1·3448 ..	92	1·3865 ..	67	1·4373 ..	42
1·3464 ..	91	1·3883 ..	66	1·4396 ..	41
1·3479 ..	90	1·3902 ..	65	1·4418 ..	40
1·3494 ..	89	1·3920 ..	64	1·4441 ..	39
1·3510 ..	88	1·3939 ..	63	1·4464 ..	38
1·3526 ..	87	1·3958 ..	62	1·4486 ..	37
1·3541 ..	86	1·3978 ..	61	1·4509 ..	36
1·3557 ..	85	1·3997 ..	60	1·4532 ..	35
1·3573 ..	84	1·4016 ..	59	1·4555 ..	34
1·3590 ..	83	1·4036 ..	58		
1·3606 ..	82	1·4056 ..	57		
1·3622 ..	81	1·4076 ..	56		
1·3639 ..	80	1·4096 ..	55		
1·3655 ..	79	1·4117 ..	54		
1·3672 ..	78	1·4137 ..	53		
1·3689 ..	77	1·4158 ..	52		
1·3706 ..	76	1·4179 ..	51		

In the next table, the temperature corrections in units of the 5th decimal place of the refractive index, for temperatures from 10 to 30° C., and water contents from 30 to 100 per cent., are given.

* We find that these values practically corroborated those originally published by Main (this *Jl.*, 1907, 481,531), showing that this investigator must have worked with great care in his early experiments. Selecting values here and there we have for Schönrock and Main respectively: 40·0, 40·05; 60·0, 60·0; 80·0, 79·9; 95·0, 94·8.

t	100	95	90	85	80	75	70	65	60	55	50	45	40	35	30
10	72	80	89	97	105	114	122	131	139	147	156	164	172	180	189
12	60	67	73	80	86	93	100	106	113	119	126	132	138	145	151
14	47	52	57	62	66	71	76	81	86	90	95	100	104	109	114
16	32	36	39	42	45	48	51	55	58	61	64	67	70	73	76
18	17	19	20	22	23	25	26	28	29	31	32	34	35	37	38
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	18	20	21	23	24	26	27	28	30	31	33	34	36	37	38
24	38	41	43	46	49	52	55	58	60	63	66	69	72	74	77
26	58	63	67	71	75	80	84	88	92	96	100	104	108	112	116
28	80	86	92	97	102	108	113	119	124	129	134	140	145	150	155
30	104	111	118	124	131	137	144	150	156	163	169	176	182	188	195
32	129	137	144	152	160	167	175	182	190	197	205	212	220	227	235
34	155	164	172	181	190	198	207	215	224	232	241	249	258	266	275
36	182	192	202	211	221	230	240	249	258	268	278	287	296	306	315

Evaporation of Juice in the Kestner Evaporator under High Pressure. *By M. Zuew. Zapiski, 6, 305;* through *Centr. Zuckerind., 1911, 19, 1088.*

In evaporating sugar juices in the Kestner evaporating apparatus, the juice boils in the first body at 130° C., at which temperature no destruction of sugar is claimed to take place. So as to test the accuracy of this statement, the author instituted a number of experiments in the laboratory of the Technische Hochschule at Kharkov in Russia. Using siloed beets of an average sugar content of 19 per cent., extraction was effected in a laboratory diffusion plant, and the resulting juice submitted to double carbonatation, a liquor of 20·7° Brix, 18·5 per cent. sucrose, 0·016 per cent. of reducing sugars, 0·013 per cent. alkalinity, and 89·4° purity being obtained. Of this carbonatated juice, 200 grm. quantities were heated in a copper-lined autoclave, the flame being so regulated that the manometer reading remained constant for periods of time from 5 to 15 minutes, after which the contents of the autoclave were rapidly cooled by immersing in ice and water. After weighing the juice, it was adjusted to normal temperature, cooled and analysed, the Brix, sucrose content, reducing sugar content, and alkalinity being determined. As the result of these experiments, which are summarized in ten lengthy tables, the author comes to the following general conclusions: (1) Carbonatated beet juice, on being heated to 130° C. for 5 to 10 minutes, remains quite unaffected, and (2) the highest temperature to which carbonatated beet juice may be heated for 5 to 10 minutes without inversion taking place is 134° C. From these experiments, therefore, it may be accepted that, so far as beet

factories are concerned, there is no risk of carrying the temperature in the first body of the Kestner evaporator as high as 134° C., *i.e.*, under a pressure of two atmospheres.

DETERMINATION OF INVERT SUGAR (GLUCOSE) IN RAW SUGARS. *By Ed. Hoppe. Österr.-Ungar. Zeitsch. Zuckerind. u. Landw., 1911, 40, 165-169.*

With the object of replacing the standard Herzfeld gravimetric method of determining reducing sugars by one that is less tedious, the author has investigated the volumetric process, and has come to the conclusion that a modification of Bang's procedure (this *Jl., 1908, 461*) is the most suitable, being both accurate and easily carried out. According to this method, the solution containing the reducing sugars is boiled with Soldaini's solution,* to which potassium sulphocyanide has been added, when white cuprous sulphocyanide is quantitatively precipitated, after which the excess of copper solution is determined volumetrically by a solution of hydroxylamine sulphate. In order to prepare the necessary solutions it is best to proceed as follows:—(1) *Copper solution:* 250 grms. of potassium carbonate and 200 grms. of potassium sulphocyanide are introduced into a standard litre flask, about 700 c.c. of water, previously heated to about 70° C. poured in, the mixture shaken until all solid matter is in solution, and then cooled to 25-30° C. To this liquid is now added a cold solution of 50 grms. of powdered sodium bicarbonate in 100-150 c.c. of water, and then one, likewise cold, containing 6·25 grms. of pure cupric sulphate in a suitable amount of water, the flask being shaken until the precipitate which at first forms is all dissolved. After this, the volume of the liquid is completed to the mark, the whole well mixed, allowed to stand for 24 hours, again adjusted to the mark, mixed, and finally filtered. (2) *Hydroxylamine solution:* 100 grms. of potassium sulphocyanide are dissolved in cold water in another standard litre flask, 1·625 grms. of hydroxylamine sulphate added, the whole made up to the mark, and, if necessary, filtered after standing for 24 hours. For carrying out the determination of invert sugar (glucose) in raw sugars, using these two solutions, the author advises the following method of working: 10 grms. of the sample of sugar, dissolved in a little water in a 100 c.c. flask, are clarified with a little alumina, the solution made up to the mark, and passed through a dry filter. Exactly 10 c.c. of the clear solution are pipetted into a wide-necked flask of about 200 c.c. capacity, and then 50 c.c. of the copper solution carefully added, also by means of a pipette. This liquid, heated over wire gauze by means of a low flame, is boiled for exactly three minutes, and rapidly cooled to 20-30° C. Then the

* Solution of cupric sulphate in potassium bicarbonate solution.—(Ed. *I.S.J.*)

hydroxylamine solution is added quickly from a burette until the blue of the liquid changes to a yellowish colour. If this requires more than 44-45 c.c., then the raw sugar under examination contains less than 0·05 per cent. of invert sugar, and may be called "invert sugar free." When, however, less hydroxylamine solution than this is used, the exact invert sugar content of the sample is ascertained from a table constructed by working with pure invert sugar solutions, under exactly the same conditions. It should be noted that the copper and hydroxylamine solutions should be so adjusted that 50 c.c. of the first, diluted with 10 c.c. of water, should require 49·9-50·1 c.c. of the latter to effect complete decolorization.

THE RAFFINOSE CONTENT AND THE NON-SUGAR RATIO OF RAW BEET SUGARS. *By F. Strohmer. D. Zuckerind., 1911, 36, 341-342.* See also this *Jl., 1910, 596; 1911, 49* and *50*.

By many chemists the ratio of the ash to the organic non-sugar substances contained in a raw beet sugar has been regarded as a useful indication of its quality, and Gawalovski maintained that for first products the ratio was constant, being 1 : 1·5. Recently at the Raffinose Conference held at Berlin (*cf.* this *Jl.*, 1910, 567-568) the British chemists stated that in all sugars showing a lower ratio than 1 : 1·5 raffinose is probably present, but with this the author does not agree. He has examined 18 typical raw sugars stated to be first-products from different Austro-Hungarian factories, with the following results:—

	1–6.	7–12.	13–18.
Direct polarization	93·80 - 96·30	94·20 - 96·50	95·10 - 96·70
Water	1·40 - 3·96	1·25 - 3·06	1·40 - 3·20
Ash	0·88 - 1·32	0·94 - 1·16	0·84 - 1·13
Organic non-sugar	1·36 - 2·03	1·20 - 1·63	0·86 - 1·27
Ratio..	1·50 - 1·55	1·22 - 1·47	1·02 - 1·13
Sucrose by Clerget	93·54 - 96·19	94·00 - 96·34	95·05 - 96·63
Sucrose calculated from the Raffinose formula ..	93·40 - 96·11	93·89 - 96·24	95·03 - 96·59
Raffinose	0·00 - 0·26	0·12 - 0·25	0·01 - 0·20

It is seen from these figures that there is no fixed relationship between the raffinose content and the ratio; but that, on the contrary, it seems as though sugars with the lowest ratio show the smallest difference between the direct polarization and the sugar content calculated from the raffinose formula, and are therefore the least likely to contain raffinose. Further evidence was obtained from the analysis of more than 300 different raw sugars, which neither partially

nor wholly originated from a molasses desaccharification process, and were thus not after-products. In these the difference between the direct polarization and the sugar content by Clerget varied between —0·38 and +0·28 per cent., so that all could be regarded as free from raffinose, although amongst these were many in which the ratio was less than 1·5. From these results the author concludes that the occurrence of appreciable amounts of raffinose is limited to those sugars which are wholly or partly produced by a desaccharification process, and for such the statement of the British chemists applies, since in these the amount of raffinose is always the higher the smaller the ratio. With Sachs (*Sucr. Belge*, 1911, *39*, 261-264), the author agrees that it is useless to examine for raffinose all normal sugars having a smaller ratio than 1·5, although such an examination is practical and reasonable in the case of products originating from a desaccharification process.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E. Chartered Patent Agent, 6, Lord Street, Liverpool; 77, Market Street, Bradford; and 285, High Holborn, London.

ENGLISH.—Applications.

12642. H. Wiase. *Process for the refinement of sugar.* (Complete specification). 25th May, 1911.

13965. D. Kabili. *Machine for rolling and spinning plastic sugar stuffs and the like for confectionery.* 12th June, 1911.

14181. J. Miller. *Sugar cane and the like crushing-mills.* (Complete specification). 15th June, 1911.

Abridgment.

4673. H. W. Aitken, Glasgow. *Improvements in hydraulic pressure regulating apparatus for sugar cane mills.* Date of application, 24th February, 1911. This invention relates to an improved hydraulic regulating apparatus for sugar cane mills comprising regulating cylinders and their rams arranged between crossheads carried on the headstock king-bolts (extended in length for that purpose) and the headstock bearing covers, and plunger-like distance pieces within apertures in the covers and engaging on the one hand the roll bushes, and on the other hand engaged by the regulating cylinders or rams.

GERMAN.—Abridgments.

234287. Eudo Monti, of Turin, Italy. *A refrigerating trough for concentrating solutions more particularly sugar juice by freezing and*

compression. (Patent of Addition to Patent No. 194235 of 8th September, 1905.) 9th May, 1909. This is an improvement on the refrigerating trough, according to Patent No. 194235, and has the form of a trough of rectangular section having parallel refrigerating pipes arranged in it consisting of several superimposed series of separate elements, each of which consists of one or more rows of horizontal pipes and end beams through which the pipes are passed, the latter being tightly packed against the end beams of the adjacent elements.

234369. GUSTAV DIETZ, of Brunswick. *Apparatus for automatically testing water of condensation and the like as to its saccharine contents.* 16th February, 1910. This apparatus has a number of glasses for re-agents arranged on a rotary frame and these glasses which are each provided with a syphon and a guiding frame or attachment are successively brought beneath the outlets of the water to be tested and the vessels containing the re-agents which are so operated by means of the attachments or a cock controlled by the rotary frame, that each glass on the rotation of the frame receives the necessary quantity of liquid which it automatically discharges again at another place by encountering a fixed abutment of a lower part which closes the apparatus. A further arrangement of the apparatus consists in the outlets of the two vessels containing re-agents being connected with the measuring tap in such a way that the chambers of the cock at each full or patial rotation deliver the necessary quantity of liquid and discharge it into horizontal discharge pipes which in turn discharge over the re-agent glass which is standing each time ready.

Estimate of Principal Cane Crops of the World

(From J. W. de Silva & Co.'s Report.)

	Crop made.	1910-11.	1909-10.	1908-09.	1907-08.
Chief Countries supplying Europe and America.					
Java	May-Nov. .	1,200,000	1,290,000	1,266,000	1,240,000
Réunion	Aug.-Jan. .	35,000	40,000	37,000	39,000
United States. .	Sept.-Jan. .	300,000	330,000	370,000	352,000
Peru	Oct.-Feb. . .	140,000	150,000	140,000	160,000
Brazil	,, ,, ..	260,000	270,000	240,000	220,000
Demerara	,, ,, ..	100,000	100,000	110,000	100,000
Surinam and Venezuela .	,, ,, ..	15,000	16,000	15,000	15,000
Hawaii	Dec.-April.	490,000	480,000	477,000	465,000
Mexico	,, ,, ..	150,000	150,000	130,000	115,000
Cuba	Dec.-June.	1,500,000	1,800,000	1,514,000	960,000
Porto Rico....	Jan.-June..	300,000	308,000	240,000	190,000
St. Domingo and Hayti.	,, ,, ..	70,000	69,000	62,000	50,000
Trinidad and Tobago ..	,, ,, ..	50,000	55,000	55,000	48,000
Barbados.... .	,, ,, ..	40,000	36,000	13,000	30,000
Jamaica	,, ,, ..	10,000	7,000	5,000	12,000
Antigua and St. Kitts..	,, ,, ..	20,000	25,000	22,000	20,000
Other British West Indies	,, ,, ..	7,000	8,000	8,000	8,000
Martinique	,, ,, ..	40,000	40,000	40,000	39,000
Guadeloupe . . .	,, ,, ..	40,000	40,000	36,000	35,000
St. Croix......	,, ,, ..	15,000	15,000	14,000	13,000
Central America	,, ,, ..	15,000	15,000	14,000	15,000
Total Tons............		4,797,000	5,244,000	4,808,000	4,126,000
Countries consuming own productions, or exporting chiefly to East.					
Argentina	June-Oct...	140,000	130,000	164,000	109,000
Australia and Fiji	June-Nov..	290,000	220,000	235,000	280,000
British India..	Dec.-May..	2,100,000	2,125,000	1,900,000	2,050,000
Egypt	Jan.-June..	50,000	50,000	48,000	60,000
Formosa	Dec.-June..	200,000	160,000	125,000	80,000
Mauritius	Aug.-Jan..	200,000	235,000	191,000	170,000
Natal	,, ,, ..	70,000	63,000	35,000	34,000
Philippines....	Nov.-Mar..	160,000	116,000	123,000	137,000
Total of **Cane**........		8,007,000	8,343,000	7,629,000	7,046,000
Beet—Europe		8,127,000	6,138,000	6,544,000	6,562,000
,, United States.		455,000	450,000	384,000	440,000
Cane and Beet		16,589,000	14,931,000	14,557,000	14,048,000

UNITED KINGDOM.

IMPORTS AND EXPORTS OF SUGAR
To End of June, 1910 and 1911.

IMPORTS.

Unrefined Sugars.	1910. Tons.*	1911. Tons.*	1910. £	1911. £
Russia	....	609	....	6,612
Germany	91,720	287,273	1,237,304	2,923,393
Netherlands	5,389	3,266	64,725	29,927
Belgium	3,003	3,565	37,139	33,596
France	409	47	5,864	425
Austria-Hungary	40,102	37,348	535,204	373,201
Java	1,113	1,611	16,364	18,772
Philippine Islands	....	....	....	....
Cuba	90,140	3,240	1,281,439	24,669
Dutch Guiana	3,238	3,587	46,292	42,078
Hayti and San Domingo	62,029	23,280	873,172	249,088
Mexico	10,000	6,435	142,359	74,654
Peru	32,924	17,024	441,525	159,001
Brazil	46,535	7,458	563,465	62,184
Mauritius	22,736	23,563	336,730	199,201
British India	6,162	500	65,570	4,098
Straits Settlements	792	....	9,389	....
Br. West Indian Islands, Br. Guiana & Br. Honduras	53,048	39,698	778,835	532,527
Other Countries	15,556	9,876	206,098	92,454
Total Raw Sugars	484,896	468,380	6,641,474	4,825,880
Refined Sugars.				
Russia	94	30,009	1,452	368,008
Germany	186,063	215,145	2,926,165	2,793,415
Holland	44,440	62,786	728,285	858,879
Belgium	14,191	18,862	242,797	260,268
France	49,348	3,007	811,680	44,082
Austria-Hungary	101,596	107,861	1,657,465	1,421,736
Other Countries	41,457	190	719,128	2,649
Total Refined Sugars	437,190	437,860	7,086,972	5,749,037
Molasses	86,790	64,445	400,221	263,709
Total Imports	1,008,876	970,685	14,128,667	10,838,626

EXPORTS.

British Refined Sugars.	Tons.	Tons.	£	£
Denmark	2,037	2,506	29,505	29,266
Netherlands	1,561	1,519	24,184	20,250
Portugal, Azores, & Madeira	685	643	9,847	7,341
Italy	134	842	1,855	9,879
Canada	3,405	3,889	54,243	56,530
Other Countries	3,882	6,122	72,222	94,106
	11,703	15,521	191,856	217,372
Foreign & Colonial Sugars				
Refined and Candy	372	664	7,042	9,515
Unrefined	2,563	4,282	36,886	50,065
Various Mixed in Bond	75	....	1,285	....
Molasses	185	227	1,400	1,526
Total Exports	14,898	20,694	238,469	278,478

* Calculated to the nearest ton.

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1911. Tons.		1910. Tons.
Total Receipts January 1st to June 29th	1,278,081	..	1,425,407
Receipts of Refined ,, ,, ...	231	..	149
Deliveries ,, ,, ...	1,225,211	..	1,361,375
Importers' Stocks, June 28th	52,870	..	67,382
Total Stocks, July 5th	226,000	..	375,270
Stocks in Cuba, ,, ...	185,000	..	251,000
	1910.		1909.
Total Consumption for twelve months ..	3,350,355	..	3,257,660

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR FOR 1909, 1910 AND 1911.

(Tons of 2,240 lbs.)	1909. Tons.		1910. Tons.		1911. Tons.
Exports	978,249	..	1,176,894	..	986,688
Stocks	326,301	..	407,668	..	332,260
	1,304,550	..	1,584,562	..	1,318,948
Local Consumption (5 months)..	27,130	..	28,252	..	29,530
	1,331,680	..	1,612,814	..	1,348,478
Stock on 1st January (old crop)..	....	..	....	..	....
Receipts at Ports up to 31st May.	1,331,680		1,612,814		1,348,478

Havana, 31st May, 1911. J. GUMA.—F. MEJER.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION OF SUGAR FOR SIX MONTHS ENDING JUNE 30TH, 1909, 1910, 1911.

	IMPORTS.					EXPORTS (Foreign).		
	1909. Tons.		1910. Tons.		1911. Tons.	1909. Tons.	1910. Tons.	1911. Tons.
Refined	505,718	..	437,190	..	437,860	418 ..	372 ..	664
Raw	400,234	..	484,896	..	468,380	1,985 ..	2,638 ..	4,283
Molasses	84,334	..	86,790	..	64,445	92 ..	185 ..	227
	990,286		1,008,876		970,685	2,495	3,195	5,174

	HOME CONSUMPTION.				
	1909. Tons.		1910. Tons.		1911. Tons.
Refined	496,637	..	403,291	..	433,357
Refined (in Bond) in the United Kingdom........	289,625	..	298,711	..	327,286
Raw	59,076	..	66,172	..	60,874
Molasses	70,074	..	75,382	..	62,548
Molasses, manufactured (in Bond) in U.K........	37,338	..	36,006	..	39,348
Total...........................	952,750	..	879,562	..	923,413
Less Exports of British Refined.................	15,750	..	11,703	..	15,521
	937,000		867,859		907,892

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, JUNE 1ST TO 30TH, COMPARED WITH PREVIOUS YEARS.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1911.
177,100	898,340	268,020	407,040	207,830	1,958,330

	1910.	1909.	1908.	1907.
Totals ..	..1,663,930..	1,900,680..	1,941,300..	2,086,380.

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING MAY 31ST, IN THOUSANDS OF TONS.

(Licht's Circular.)

Great Britain.	Germany.	France.	Austria-Hungary	Holland, Belgium, &c.	Total 1910-11.	Total 1909-10.	Total 1908-09.
1890	1333	749	643	239	4855	4752	4650

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1910-1911. Tons.	1909-1910. Tons.	1908-1909. Tons.	1907-1908. Tons.
Germany	2,602,000 ..	2,033,834 ..	2,082,848 ..	2,129,597
Austria	1,535,000 ..	1,256,751 ..	1,398,588 ..	1,424,657
France	725,000 ..	806,405 ..	807,059 ..	727,712
Russia	2,140,000 ..	1,126,853 ..	1,257,387 ..	1,410,000
Belgium	285,000 ..	249,612 ..	258,339 ..	232,352
Holland	223,000 ..	198,456 ..	214,344 ..	175,184
Other Countries .	590,000 ..	465,000 ..	525,300 ..	462,772
	8,100,000	6,136,911	6,543,865	6,562,274

THE

INTERNATIONAL SUGAR JOURNAL.

No. 152. AUGUST, 1911. Vol. XIII.

☞ All communications to be addressed to the Editor, Office of "The Sugar Cane," Altrincham, near Manchester. All Advertisements to be sent direct.

☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

Cheques and Postal Orders to be made payable to NORMAN RODGER, Altrincham.

The Editor will be glad to consider any MSS. sent to him for insertion in this Journal and will endeavour to return the same if unsuitable; but he cannot undertake to be responsible for them unless a stamped addressed envelope is enclosed.

NOTES AND COMMENTS.

The Beet Sugar Outlook in England.

There has not been much public activity lately in the advancement of sugar beet projects in this country; but some progress has apparently been made behind the scenes. A correspondent of *The Times*, who is presumably well informed, sums up the situation as follows :—" There are indications of renewed interest in the proposals to establish sugar beet factories in England. A scheme for a factory near Maidstone is at an advanced stage, and fears have been expressed as to whether the venture may not be made on too small a scale. Mr. Ali Cohen, the representative of a Dutch syndicate, which is responsible for the Norfolk crops, speaks of the probability of a large company being floated to establish a factory not far from Norwich. Meantime there is talk of a reconstitution of the board of the East Anglian Company which has had for some time the control of the excellent site for a factory near Maldon. A good deal of sympathy is forthcoming for this scheme, though it is understood that the Government has refused an application for assistance with debentures. Near the Maldon site there is land peculiarly well suited for beet, and near Snape, in Suffolk, with which there is easy water communication, some 150 acres of beet are being grown. Some doubt exists as to the extent of the area of beet in Norfolk, but it is unlikely that it greatly exceeds this acreage. There can be no question as to the

interest which is being taken in Holland and also in Germany in the sugar beet propaganda in this country. It has been suggested that if action is not taken by English capitalists, Dutch financiers will come over and start a factory of their own. The National Beet Sugar Council continues its missionary efforts at the agricultural shows, and Lord Denbigh's National Sugar Beet Association, with which Mr. Drake, of Mincing-lane, and Captain Morrison, M.P., are connected, pursues its investigations on the Continent and in promising districts in England. A crop of some size has already been grown in Ireland for one of the Dutch companies."

Apart from this, we hear of a prolonged campaign carried on by Mr. Sigmund Stein (acting as Technical Adviser to Beet Sugar Founders Ltd., of Liverpool) to interest the Cornish farmers in the art of beet growing. His efforts are undoubtedly praiseworthy, and it is to be hoped that the projected factory will receive an adequate measure of support; but why will he persist in painting so rosy a prospect, and take experimental results as likely to be all but confirmed on a commercial scale? We are told experimental results in Cornwall have given 18 to 19 per cent. of sugar, and 18 to 26 tons to the acre; but to hold out to the farmers the consequential prospect of getting £18 to the acre (18 tons at £1 per ton) strikes us as a grossly over-sanguine estimation. What experts in actual beet sugar countries think of our prospects may best be gauged from a perusal of the following strong comments taken from the current number of the *Sugar Beet* (an American publication edited in Paris).

"Imaginary Hopes of Profits in England."

"A great mistake is frequently made when organizing new factories. A few acres here and there are planted in beets and the resultant product is analyzed. Calculations are thus made which are very misleading. In England there is considerable agitation for introducing the beet-sugar industry. The circulars sent out are unreliable; they suppose that the average yield per acre in Germany is 13 tons and in England 16 tons. They show that while Germany obtains 1·98 tons of sugar per acre, England can extract 2·35 tons. 'This means for a factory working 2,000 acres, such as is going to be erected, about 800 tons more sugar yearly. . . . The English factories could produce as much as 2,000 tons of sugar per factory yearly more than in Germany. . . . The yield of 16 tons is taken low for security sake. . . . . Conversing with some farmers the other day, several declared that an average of 20 tons of roots per acre and higher has been obtained. . . . If 17 per cent. of sugar be delivered at the factory at $5 (£1), per ton, the clear profit to the farmer will be $32 (£6 8s.) per acre.'

"Various arguments were advanced in an attempt to prove that beets could be successfully grown on almost any semi-worn-out

pasture land, but farmers now find that this is not true. Deep ploughing and continuous working of the soil before and during the beet's development are among the many essentials for success. In England, like elsewhere, very little reliance should be placed upon the results obtained on experimental plots. In such cases exceptional care is given to all the requisites of scientific cultivation, which in practice are not profitable, for the cost would leave no money for profit. They calculate that the working expenses, based upon German data, are to be about \$1·50 (6/-) per ton. Six tons of sugar beets will yield one ton of sugar; the price of sugar per ton is \$40 (£8); the net profit is \$10 (£2); the profit will be over 20 per cent. on invested capital. What surprises await those who place absolute faith in these calculations! They expect a sugar extraction of 16 per cent. and will practically get 12 to 13 per cent. We insist that there is and has been too much misinformation circulated. Better tell the truth at the start."

Australian Sugar Affairs.

Matters in Australian sugar circles do not seem to be all plain sailing. The sugar industry of the Commonwealth is admittedly the most expensive of any to keep up. In order to gratify the desire for a "White Australia," the Kanakas were some years ago all deported from Queensland and their places taken by more highly paid white workers. As a protection to the industry there is a duty on sugar of £6 per ton, five-sixths of which is returned as a rebate for sugar produced by white labour at home. The result is that the consumer has to pay pretty highly for his commodity, and his interests have so far been sacrificed on the altar of the producer, who must be protected if he is to exist. There are however some murmurings at this state of affairs and it is just possible that attempts may be made to reduce the import duty and thus allow foreign black-laboured sugar to enter Australia, a contretemps that is naturally viewed with every disfavour by the sugar growers. As a matter of fact, in 1910, over 34,000 tons of cane sugar did enter Australia, mainly from Fiji, Java, and Mauritius; so that any alteration in the sugar duty would be bound to increase the imports very considerably. But while the Australian producers insist on the sugar duty being preserved intact, they are unable to take any adequate steps to cheapen the cost of production by means of an increased output, for the simple reason that they are precluded owing to their fiscal system from competing in the other markets of the world, and so can only produce that amount which Australia herself can consume. The price her sugar would fetch in competition with sugar produced by black labour would not pay for its cost. They have recently had a Commission sitting, to enquire into the possibilities of expanding the industry; and the Commission has finally reported that two more mills of a joint capacity of 15,000

tons should be built for 1913 and perhaps a third of 5,000 tons as well; and that for 1914 an 8,000 ton mill be built. No great expansion, it will be admitted; but doubtless a consideration of the population and the existing imports of foreign sugar were the chief factors to influence the decision. The average net imports during the past ten years have been calculated at something over 46,000 tons per annum.

In the face of the difficulty of exporting sugar to foreign markets at the world's price, the promoters of the Australian sugar industry are forced to cast about for some other expedient to enable them to enlarge their output. It is now seriously suggested that the money derived by the Revenue from the difference between the excise and the rebate, which difference amounts to £1 per ton, should be used to create a special fund from which could be paid an extra bonus on all sugars that require to be exported. This in plain words would be an export bounty, not differing to any practical extent from the Continental export bounties of the period prior to 1902. It would therefore be subject to the penalties imposed by the Brussels Convention, which, we suppose means, it would be admitted free to the United Kingdom, because we here have managed to shirk our obligations to that treaty in the name of *free trade*, but would be virtually excluded from all the other countries parties to the Convention. And as our sugar colonies and dominions would also take care to exclude this competition with their own industries, it must be assumed that the Australian export trade would be dependent on the British market for support, and would succeed or fail according to its ability to compete with the older sources of supply dealing with Mincing Lane.

Wholesale Prices of Sugar and Costs of Production.

An interesting document has recently been prepared by the U.S. Bureau of Statistics at the request of members of the Senate, showing the movement in sugar prices in the principal European and American markets over a period varying from eight to twenty years. These form a useful record for reference, and we think our readers will be glad to have at least a selection from them included in the pages of this *Journal*. We have therefore reproduced elsewhere the annual averages of the last eight or ten years, omitting all monthly figures, of which a good many are to be found in the original. It may be added for the benefit of British readers that it is only necessary to divide the *cents per lb*. by 2 to get *pence per lb*.

Besides the Memorandum on the Price Movement of Sugar which precedes the tables, the document contains a Memorandum on the cost of producing sugar, which reproduces Mr. Prinsen Geerligs' estimate originally appearing in this *Journal* (1911, 7) as to the cost of sugar production in Java. Unfortunately the compilers at Washington have failed to notice the correction in the subsequent issue of

our *Journal* which raised the figure of 7s. 6½d. by a sum of approximately 3d. to cover expenses of warehousing, loading, and insurance, so that when freights to Europe are 20s. per ton the cost in British ports would be 8s. 9½d., not 8s. 6½d. The same Memorandum quotes the *Produce Markets Review* and Mr. C. Czarnikow on the costs of production of beet sugar and of Cuba centrifugals; but, as regards the latter, takes exception to the figures of 6s. to 7s. (or say 6s. 6d.) per cwt. (1·42 cents per lb.) given by the London organ, stating that "while large and small estates in Cuba vary in cost of production the same as with beet factories, yet the lowest cost of the large estates is understood to be 1½ cents per pound up to 2 cents per pound for others. The average cost of production may fairly be estimated at 1·85 cents per pound f.o.b. Cuba, or say 1·95 cents c. and f. New York; 1.85 cents per pound f.o.b. Cuba is 8s. 6d. per hundredweight f.o.b. Cuba, which we must consider approximately correct for cost of Cuba production, or say 9s. 3d. per hundredweight landed in United Kingdom. . . . Beets at 8s. 10½d. (below cost production) equal centrifugals at 3·85 cents per pound New York, while Cuba centrifugals at 2 cents per pound cost and freight (above cost production) equal 3·36 cents per pound New York, a difference of one-half cent per pound, which difference in parity is usually made during the height of the crop."

We may therefore take the following figures of three large sources of supply as substantially correct:—

	s.	d.	
88% beet f.o.b. Hamburg	9	6	per cwt.
Cuba Centrifugals f.o.b. Cuba	8	6	,,
Java Raw Crystals f.o.b. Java	7	9½	,,

Personal.

We learn that Mr. Francis Maxwell, of Sydenham, London, and formerly of Java, who, it will be recollected, has recently figured amongst our contributors, has lately accepted an appointment as Technical Adviser to the Credit Foncier of Mauritius in connexion with their sugar estates. This financial house are bondholders on a large scale for some of the Mauritian estates, and their decision to secure the best expert assistance to enable them to carry on the ventures at a profit is to be commended; and we have no doubt Mr. Maxwell will fully justify his selection for the post.

The sugar year of 1910 is said to have been the most prosperous in Guadeloupe since 1884. There are 17 centrals at work dealing with canes from 60,000 acres. The average yields for the years 1905-09 have been 37,650 tons of sugar, 1,680,000 gallons of rum, and 360,000 gallons of molasses.

THE BACTERIAL DETERIORATION OF SUGAR.

(By an Occasional Correspondent.)

The May and June numbers of this *Journal* contained *in extenso* an account of the recent work of Mr. Owen, of the Louisiana Experiment Station, on the bacterial deterioration of sugar. The publication of this study which rounds off and adds very largely to the work of previous investigators, forms an excuse to collate the scattered articles on this subject which have appeared during the last 15 years. However, before doing this, it may be well to give some explanation of the term *potato bacilli*.

In the early days of bacteriology it was observed that potato formed a suitable habitat for many bacteria; it was also observed that when slices of potato were allowed to become adventitiously infected certain well defined species or varieties constantly made their appearance and to these was given the name of the *potato bacilli*. Later it was observed that some of these bacteria growing on certain media gave a growth very similar in appearance to the mesentery, hence one of them was named *B. mesentericus;* other bacteria allied to the original but differentiated by special sub-characteristics were soon found and named *B. mesentericus fuscus*, *B. mesentericus granulatus*, &c. In the confusion which will invariably arise before the systematization of any branch of natural science some of these *potato bacilli* were described independently by different observers and received different names from each observer. Thus in Chester's "Manual of Determinative Bacteriology," under *B. vulgatus*, are given as synonymous: *B. mesentericus vulgatus* and *Potato bacillus*. Following on this species are mentioned *B. lactis No. 2* and *B. peptonans*, of which it is remarked "From descriptions not differentiated from 173" (*i.e.*, *B. vulgatus*). In the same manual, under *B. mesentericus*, is given as a synonym *B. mesentericus fuscus*, and as varieties *B. mesentericus fuscus granulatus* and *B. mesentericus fuscus consistens*, and as not differentiated from this one *B. lactis No. 4*. It is thus highly probable that the same organism often has been isolated by many observers, and being described according to the caprice of each observer has failed to establish its identity; (in quite a different field a similar confusion has arisen in regard to cane varieties). It is also possible, and indeed probable, that many so-called species are merely varieties, the observed differences being varietal and not specific. Thus, from a bacillus grown in pure culture from a single cell, certain individuals can be selected with differentiated characteristics whence a separate "species" may be claimed. From this species, however, it may be possible to work back by a reverse selection to the original type. This differentiation into "species" may be sometimes obtained by change in habitat or environment, as Hansen was in this way able to obtain a non-sporing yeast from a normal spore-forming species, and

the former under the present accepted system of nomenclature would be classed as *Torula*, and not as *Saccharomyces* at all. The question of the multiplication of species and their identity and passage one into another has been very thoroughly studied in so far as regards the pathogenic *coccaceae* by C. E. A. and A. R. Winslow.

In the classification of bacteria generally the genus *Bacillus* includes unicellular organisms varying in length from short ovals to rods, and distinguished from the genus *Bacterium* by the presence of flagella. The potato bacilli form a group in class XV. of Chester's classification, the other groups in this class being the *Uro-bacilli* and the *B. subtilis* group.

This group of bacilli is one of considerable economic importance; they are of cosmopolitan distribution in air, in soil, and in water; their function in nature is probably the analysis and degradation of organic matter in the soil, and by reason of this they are of very great importance in agriculture, in fact it might be said necessary; owing to their wide distribution they find their way into sugar house products, and when there they may be described as beneficial organisms in the wrong place, misapplying their natural functions.

The outstanding characteristics of this group are their cosmopolitan distribution, their faculty of living on media only slightly nitrogenous (*e.g.*, potatoes, raw sugar), the production of gum and resistance to elevated temperatures.

This somewhat extended digression on the term *potato bacilli* is necessary to appreciate properly the sequence of work on the deterioration of sugars done during the last fifteen years.

Maxwell in Louisiana in 1896 was probably the first to connect deterioration of sugar with the presence of micro-organisms, and he ascribed it to the lactic and butyric acid bacteria. Shorey in 1898 in Hawaii investigated the deterioration of sugar, and ascribed it principally to the presence of the mould fungus *Penicillium glaucum;* he also noticed that alkalinity was no assurance that sugar would keep. Shorey's views were confirmed in 1899 by Kamerling in Java, who found in sugar there 20 species of fungi related to *Penicillium*, and ascribed the initial deterioration to these organisms, and followed by a subsequent deterioration due to yeasts after the sugar had become very moist. Later, in 1903, the same observer found that sugars leaving the driers in Java were sterile, and ascribed the source of infection to the bags and containers. In 1900 Laxa made a study of the bacteria which occur in the beet sugar factories. He found the dominant organisms to be a spore-forming gum producing species to which he gave the name *Clostridium gelatinosum;** he observed the thermophilous nature of this organism; he attributes the infection of

*In Lohnis' Handbuch der landwirtschaftlichen Bakteriologie this organism is stated to be the same as *Bac. gummosus*, Ritsert; this is placed by Chester among the Potato bacilli.

sugar first to the soil adhering to the roots, and secondly to infection from the air; later Velich expressed the opinion that this organism is identical with *B. levaniformans* of Grieg Smith. In 1901 and 1904 Schone made more detailed studies, and found in beet juices *Leuconostoc mesenterioïdes*, colon-like bacteria, *B. mesentericus fuscus*, *B. subtilis*, *Clostridium gelatinosum*, and various indifferent and accidental organisms.

Greig Smith in Australia in 1903 ascribed the deterioration of sugars to one specific organism which he named *B. levaniformans*, the formation of gum levan being one of the distinctive characteristics of this organism. Owen has, however, shown that this property is also possessed by *B. vulgatus* and *B. mesentericus*, isolated directly from soil; hence this specific property breaks down, and it would be more reasonable, as Owen suggests, to regard *B. levaniformans* as a derived form of the potato group of bacilli. Deerr and Norris in 1907 observed five types of bacteria in Hawaiian sugar, and only very rarely encountered other organisms; they showed that sterile sugar remained unchanged under untoward conditions of storage, and found that sugars with less than 1 per cent. of water did not deteriorate. In opposition to the views put forward by Kamerling, they found that heating sugar at a dry heat under conditions similar to those obtaining in driers had no effect on the number of bacteria, and also that the gunny bags used in Hawaiian mills were sterile. Lewton-Brain and Deerr in 1909 described five species of bacteria of occurrence in Hawaiian sugars, giving full morphological and cultural descriptions. These descriptions, following on the work of Owen, are sufficient to place the bacilli they cultivated amongst the potato group, two forms being probably to be referred to, *B. vulgatus* and *B. mesentericus*. The work of these observers has now been completed by Owen in Louisiana, who, while identifying the bacteria occurring in sugars, has amongst others made the observations that the gum formation is due to an extra-cellular enzyme secreted by these bacteria, which are most active in an alkaline medium. The balance of evidence summarized above seems to point to bacteria being the dominant cause of sugar deterioration rather than to fungi (though these may also do harm), and avoiding questions of nomenclature or identity, it is safe to say that these organisms belong among those known as the potato bacilli. Assuming that it is these that cause loss, it is now possible to definitely formulate an active plan of campaign, the following of which should reduce deterioration loss to the vanishing point.

The three points of infection of sugar are—

a. The canes themselves; for, owing to the ubiquity of the *potato bacilli*, the canes, and especially the soil which comes into the factory attached thereto, must introduce large numbers of bacteria.

b. The low sugars stored over long periods, which will contain

some bacteria which have survived the passage through the boiling house and which will have become additionally infected from the air.

c. The dirty water often used at and about the centrifugals.

The bacteria entering with the juices can be destroyed by the use of a high temperature heating, or at a later stage by the use of a pre-evaporator, and under a proper system of control no loss of sugar is to be apprehended on this score.* A similar method can be used to destroy the bacteria in the low sugars when these are remelted. The third source of infection can be prevented by using at the centrifugals only clean water; the condensed water found in abundance in sugar factories should form a suitable supply.

Since, in addition to bacteria, a certain definite amount of water is required for bacterial activities to be manifested, an additional safeguard is obtained by preparing sugars as dry as possible and by avoiding such operations in the factory which might lead to the formation of hygroscopic salts.

BIBLIOGRAPHY OF THE DETERIORATION OF SUGAR.

Maxwell, *Louisiana Planter*, 1896, 154.

Shorey, *Journal of the Society of Chemical Industry*, 1898, 555.

Kamerling, *Archief voor die Java Suikerindustrie*, 1899, 529; 1903, 122.

Laxa, *Zeitschrift für Zuckerindustrie in Böhmen*, 1900, 423.

Schone, *Zeitschrift für Deutsche Zuckerindustrie*, 1901, 453; 1904, 1000.

Grieg Smith, *Proceedings, Linnean Society of N.S.W.*, 1903, 389.

Deerr and Norris, *Bulletin 24, Agricultural and Chemical Series*, H.S.P.A. Experiment Station.

Lewton-Brain and Deerr, *Bulletin 9, Pathological and Physiological Series*, H.S.P.A. Experiment Station.

Owen, *Bulletin 125*, Agricultural Experiment Station, Louisiana State University.

THE CORRELATION BETWEEN THE SUGAR AND POTASH CONTENTS OF CANE JUICE.

By H. C. PRINSEN GEERLIGS.

We have already had occasion to observe more than once (*cf.* this *Jl.*, 1910, 635) that although the amount of exhausted molasses produced from a given quantity of cane varies considerably according to the quotient of purity of the juice, yet its composition, and especially the percentage of potash, does not show any considerable variation.

It is possible to exhaust every normal cane molasses to an apparent quotient of purity of 30, and that is why (for every 100 parts of dry

*See *Bull. 36, Agricultural and Chemical Series*, H.S.P.A., and also this *Journal*, 1911, 212 and 282.

substance which it contains), the lower the initial quotient of purity of the cane juice the greater is the amount of molasses produced. Thus a cane juice, having an apparent quotient of purity of 90, gives only 15·7 parts of exhausted molasses of a quotient of 30 for every 100 parts of dry substance; whereas with an initial quotient of purity of the juice as low as 75 this figure rises to 39·3.

On analysing exhausted molasses, originating from cane juice of a high purity, we never find them to differ much from those which had been derived from juices of a very low purity, the content of glucose, ash, and even other constituents, being identical in many instances. The non-sugar in the molasses is composed of glucose, its decomposition products, and salts, among which latter the potash salts are the most conspicuous. The molasses also contains lime salts, but the latter are not derived from the juice, as they have been introduced during manufacture, and we therefore exclude them from present consideration.

While the glucose, its decomposition products, and the potash salts all go to form the non-sugar of the cane juice molasses, it has been noticeable that the ratio of potash to dry substance in such molasses is but little subject to variation, though the quantity of molasses to the same amount of dry substance in the juice shows considerable differences. For example, in the case of juice of 75 purity yielding $2\frac{1}{2}$ times the quantity of molasses which is produced by juice of 90 purity, the potash content of the latter is by no means $2\frac{1}{2}$ times that of the former; and this is only what may be expected if both had contained at the outset the same ratio of potash to dry substance content. As, however, this potash content does not differ, we are compelled to admit the fact that generally a cane juice of low purity is more charged with potash salts than a juice having a high quotient of purity.

This would not be anything to wonder at, and indeed should be evident enough if the quotient of purity in the juices depended entirely, or even to an important degree, on the content of salts, as in such a case it would be very natural that a low quotient should be accompanied by a high figure for the salts. But it is chiefly the glucose which influences the figure for the purity, and only to a very insignificant degree do the salts affect it; therefore it results that in practice the glucose in the ripe canes is accompanied by a quantity of potash salts, with which it combines in a kind of fixed proportion. This thesis may also be formulated thus: Potash salts keep back in the cane juice a certain amount of glucose, which does not disappear during the ripening of the cane, thereby lowering the quotient of the purity of the juice, and increasing the amount of molasses in such a manner that the figure for the molasses in the exhausted molasses between certain limits always attains the same percentage.

If the potash salts really prevent part of the glucose disappearing

during the ripening period of the cane, a ripe sugar cane would contain more glucose the higher the content of the potash salts. If canes are to be selected from their sugar content, then those varieties having juice with the least amount of potash should be used.

This has already been done unconsciously in the selection of the beetroot, of which a variety with a very low potash content has been obtained simply by selecting only those having the highest sugar content and using them for seed bearers. The increase in the sugar content of the improved beetroot has been automatically accompanied by a decrease in its potash content, and the investigations of E. Saillard and Andrlik Urban and many others leave no doubt that the more sugar a beet contains the less will be the amount of potash and soda salts.

Saillard made the following valuable observation. The figures that led him to the conclusion, that a high sugar content was accompanied by a low content of salts, are gathered every year from a multitude of analyses. The averages are composed of unequal figures, which for each element (calculated to the basis of 100 parts of sugar) may vary when passing from one experimental plot to another, or from one year to the other, according to the composition of the soil, the climatological conditions, the fertilizers, &c. The law is therefore far from being a mathematical one.

This last rule is more applicable to the sugar cane, since, besides the differences in the purity occasioned by the conditions of the soil, the climate, the fertilizer, and the cane variety, it is found that the degree of maturity of the cane also enters a good deal into the problem, and contributes enormously to complicating the task. Some twelve years ago, we tried to find by direct experiment whether the cane juices, which in the full maturity of the cane contain the highest sugar content, are really at the same time as poor in potash salts as the analysis of the molasses indicated.

It the first place it was necessary to find by experiment if, during the ripening of the cane and during its increase in sugar content, the quantity of potash disappeared or not in the same proportion as the glucose.

We made a large series of experiments by analysing the juice extracted from different stalks of the same stool, cut one by one at various stages of their vegetation. We repeated the experiment in different places and with different cane varieties, and also compared our results with those obtained by other investigators, but nowhere did we find it stated that the decrease in glucose, which takes place during the ripening of the cane, is accompanied by a simultaneous decrease in the ash or in the potash content. It would be beyond the scope of this paper if we tried to give a review of all the data, and we shall therefore have to confine ourselves to simply mentioning, besides the writer's own investigations, those of Bonâme in Mauritius,

of Browne in Louisiana, and of Van Houwelingen in Java, all of whom show that the figures for the ash and those for the potash in the juice of sugar cane do not change perceptibly during ripening. It is true that during the time of this ripening fluctuations in ash content are constantly observed, but they do not proceed in the same direction. Sometimes the potash content rises, sometimes it sinks, but as an average an unripe juice contains nearly the same amount of potash as it would contain if it had been expressed from the same cane at its full maturity.

Therefore if there really exists any correlation between the amount of potash, salts, and glucose, or quotient of purity, this is to be ascribed to the *natural* glucose in the cane, which depends upon the variety and the climatological conditions; but is not to be ascribed to the *accidental* glucose, which results from imperfect maturity or from over-ripeness.

It is obvious that this circumstance renders the investigation very difficult, because it is impossible to tell, when analysing a cane juice and finding a large percentage of glucose, whether this excessive quantity is produced by a defective or a too far advanced maturity, or whether that property is natural to the cane, that is to say, whether that same cane would have given the same analysis and revealed a large amount of glucose, if that analysis had been made a fortnight earlier or later.

Instead of performing the analyses in a haphazard manner, and comparing the figures obtained for the potash and the quotient of purity, which, after what has been said, would not give us a sure basis, we preferred to make numerous analyses of cane juice from estates known to produce canes of uncommonly high quotients of purity, and compare these with other juices from estates which have juices of uncommonly low quotients of purity; then further to analyse the juice of cane varieties which have a high purity and others which are noted for their impure juice.

Although the different individual results do not show any complete regularity, yet we could obtain an indication that *generally in sugar mills, where chiefly a rich and pure cane is crushed, the juices contain little potash ; while in others, where the juice of even the best ripened canes never rises above a comparatively low figure, large quantities of that element are to be found.*

The same thing may be said of the different cane varieties. The Black Java cane always yielded a rich and pure juice containing less potash than other varieties grown in the same experimental plot. Though the different varieties had been planted in the same soil, had been manured, irrigated and tilled in exactly the same way, had received the same amount of rain and sunshine, yet the *Fiji* and *Muntok* canes were not only poorer in sugar and contained a less pure juice, but the potash content of their juices was always higher than

that of the *Black Java* cane. On general lines we were able to demonstrate that some cane varieties extracted under the very same conditions a greater amount of potash salts from a given soil than others, and that the one, which extracted the least, yields at its full maturity the highest sugar content with the highest quotient of purity. Further we were able to show that the same cane variety extracts more or less potash from different soils, depending on the constitution of the latter, on the manuring, on the quantity of rain, &c.; and that also in this case, in general, the cane absorbing the least potash is predisposed to give in the mill the best results as to saccharine content, quotient of purity, and available sugar in the juice.

It should be pointed out that the results of the above investigation by no means lead us to advise planters not to use potash in their fertilizing combinations, as every plant requires that element for its growth and development, and any lack of it would result in a low tonnage, which cannot possibly be compensated by a better sugar content. Neither do the experiments point to the advisability of changing anything in the agriculture and fertilization of the cane fields; they merely give a valuable indication as to the direction in which to proceed, when it is necessary to select a new cane variety among a great number of fresh seedlings.

The production of seedling canes has, indeed, been a great success in every place where seedling canes have replaced the older varieties. Where the choice of the seedling has been made with care the yield of cane and of sugar per acre has made big strides, and although this is highly satisfactory there is still room for improvement. It is well known, that only the weight of the cane has increased, and that its sugar content is not any greater than in former days, and has in many cases even retrogaded. We account for this by the fact that the investigators, who raised the varieties, have in the main had only an open eye for the plants which possessed the greatest weight and yielded most cane to the acre, neglecting to pay attention to the sucrose content, in the belief that this would increase spontaneously after the canes had been in cultivation for a couple of generations.

These hopes have, however, so far not met with realization, and it is doubtful whether this will ever occur. Hence we think it necessary to turn our attention to the *sugar content of the canes* as well as to the growing qualities; and that is why we advise all occupied in the raising of new cane varieties from seed to analyse the juice of one stalk of the young seedlings from the cane flower and to use the figure for the potash content as one of the criteria of a probable high sugar content and a high purity in the adult state. Then, of the young plants which promise to be good growers, only those should be chosen possessing the smallest potash content, because it is these that will ultimately yield the best results as to sugar content and quotient of purity of the juice.

CONTROL OF MILL WORK.

By J. LELY.

The usual figures by which the mill work is judged are: tons of cane ground per hour, crushing, sucrose extracted per 100 sucrose in cane, &c. These data are not suitable for direct comparison, when dealing with canes having a different fibre content and juices having a different sucrose content. Instead of recording the tons of cane ground per hour, it would be more to the point to state the tons of megass produced per hour and, to be accurate, the tons of fibre produced per hour.

Maceration is recorded as water per cent. on first mill juice, although most of the first mill juice is extracted without the use of maceration water. It would be more correct to give this item also as per cent. on fibre.

Years ago I started to judge the quality of mill work by the figure: *first mill juice lost per 100 fibre,* a figure which has been of value in all kinds of calculations.

The contention is that it does not give the same value with different varieties of cane, but this applies equally to all other figures now in use. It has the advantage of eliminating five figures which by themselves are meaningless, and combining them in one neutral conception. (Sucrose in first mill juice; fibre in cane; sucrose, fibre and moisture in megass.) In Java they calculate true juice lost on 100 fibre, which is possible only when analysing the fibre in the cane. This fibre analysis will be fairly correct when grinding canes of one or two fields and only plant canes. The analysis is worthless when grinding plant and ratoon canes, canes of many fields, and all kinds of varieties.

It is then much better to assume a constant difference between the total juice and the first mill juice in the cane. In Java they call normal juice the juice obtained by dry crushing in two mills. This is not always obtainable when returning the diluted juice behind the first mill, and it is better to take it from a crusher or first mill front roller to obtain comparable results. The quantity of this first mill juice in cane is very nearly *100 — fibre — 5.* This is by means of the sucrose percentages of juice and megass. The first mill juice lost per 100 fibre is found by analysis (sucrose per cent.), the sugar extracted is weighed or measured and the cane is weighed so we can calculate the amount of fibre in the cane as follows:—

$$\text{Fibre in cane} = \frac{100 - \left(\dfrac{\text{sucrose extracted per cent. cane}}{\text{sucrose in first mill juice}} \times 100\right) - 5}{100 + \text{first mill juice lost per 100 fibre}}.$$

I have made the error elsewhere to take *100 — crushing — 5,* but the crushing is found by the Brix of the juices while first mill juice lost is found by the sucrose percentages, so these two are quite different

and may not be added up. Crushing by Brix is about 5 per cent. larger than by sucrose percentages.

Care must be taken to make a correction for the weight of cane when much is left over on Sundays, as it loses weight by evaporation of water.

In the following table I give a number of analyses of very different canes and juices, while the actual mill work, quantity and quality, are exactly the same. It shows clearly that one single figure gives no information as to what work is being done.

The figures in the table are, of course, calculated backward, not taken from practice, but they are based on practical results, to show how uniformity can be secured with the most different kinds of cane.

1	Fibre in cane	9·0	10·0	11·0	12·0	13·0	14·0	15·0	16·0
2	Sucrose in 1st mill juice	10·0	12·0	14·0	15·0	16·0	17·0	18·0	19·0
3	1st mill juice in cane..	86·0	85·0	84·0	83·0	82·0	81·0	80·0	79·0
4	1st mill juice extracted per cent. on cane	81·95	80·50	79·05	77·60	76·15	74·80	73·35	71·90
5	1st mill juice lost per cent. on cane..	4·05	4·50	4·95	5·40	5·85	6·20	6·65	7·10
6	Crushing (by Brix of juices)	86·05	84·53	83·00	81·48	79·96	78·54	77·02	75·50
7	Maceration per cent. on No. 6	15·69	17·75	19·88	22·09	24·39	26·13	29·21	31·79
8	Sucrose per cent. on cane	8·60	10·20	11·76	12·45	13·12	13·77	14·40	15·01
9	Sucrose lost per cent. on cane	0·41	0·54	0·69	0·81	0·94	1·05	1·20	1·35
10	Sucrose extracted per cent. on cane..	8·19	9·66	11·07	11·64	12·18	12·72	13·20	13·66
11	Sucrose extracted per cent. on sucrose in cane	95·23	94·71	94·13	93·49	92·84	92·38	91·66	91·01
12	Fibre in megass	47·5	48·2	46·0	49·1	44·7	45·3	46·6	49·8
13	Sucrose in megass	2·14	2·60	2·90	3·31	3·22	3·47	3·78	4·26
14	Non-sugar in megass	1·28	1·56	1·74	1·99	1·93	2·08	2·27	2·56
15	Dry substance in megass	50·92	52·36	50·64	54·40	49·85	50·85	52·65	56·62
16	Moisture in megass	49·08	47·64	49·36	45·60	50·15	49·15	47·35	43·38
17	Tons of cane ground per hour..	83·3	75·0	68·2	62·5	57·7	53·6	50·0	46·9
18	Tons of fibre produced per hour.. ..	7·50	7·50	7·50	7·50	7·50	7·50	7·50	7·50
19	Maceration on 100 fibre..	150·0	150·0	150·0	150·0	150·0	150·0	150·0	150·0
20	1st mill juice lost on 100 fibre .. .	45·0	45·0	45·0	45·0	45·0	45·0	45·0	45·0

NOTES.

Nos. 1, 2, 12, 18, 19, 20, are assumed.

No. 3:—

100 — fibre — 5.

No. 4:—

No. 3 — No. 5.

No. 5:—

$$\frac{\text{No. } 1 \times \text{No. } 20}{100}$$

No. 6:—

1·05 × No. 4.

No. 7:—

$$\frac{\text{No. } 1 \times \text{No. } 19 \times 100}{100 \times \text{No. } 6}$$

No. 8:—

$$\frac{\text{No. } 2 \times \text{No } 3}{100}$$

No. 9:—

$$\frac{\text{No. } 20 \times \text{No. } 1 \times \text{No. } 2}{100 \times 100}$$

No. 13:—

$$\frac{\text{No. } 12 \times \text{No. } 20 \times \text{No. } 2}{100 \times 100}$$

No. 14:—

Taken as 0·6 × sucrose.

No. 17:—

$$\frac{\text{No. } 18 \times 100}{\text{No. } 1}$$

Gunthorpe's, Antigua,
British West Indies.

THE PROPAGATION OF NEW VARIETIES OF CANE FROM SEED.*

It is a well recognised fact that for the best results those varieties of plants must be selected which are particularly suited for the locality in which they are to be grown. This is as true of sugar cane as of plants in general, sugar cane being in fact greatly affected by the influences of soil and climate. The range of profitable cane culture is a broad one and therefore each cane growing country requires to obtain the varieties most fitted to the environments it offers.

Louisiana in securing those canes that are best suited to its season and soil, contributes largely to the success of its sugar industry. Essentially these must be varieties tending to early maturity. Of the numerous varieties of sugar cane that can be profitably grown throughout the various sugar countries there are some which reach maturity much earlier than others, and it is these which can be utilized to the best advantage in Louisiana.

There were two early maturing canes brought into this State as far back as 1825, when the Purple and Striped (often called Red and Ribbon) that we know to-day were first introduced. Favoured by these canes, which gave greater yields of sugar than were previously possible, the industry was given a substantial impetus. This naturally led to the belief that still better varieties existed and some individual attempts were made to bring such in; but without any success for the time being.

The Sugar Experiment Station established in 1885, however, began a systematic effort to secure better varieties. The standard canes from the West Indies, the Pacific Islands, and many other distant parts were secured,—canes that had given bumper yields in Cuba, Hawaii, Jamaica, and Trinadad,—and these were tested at the Station. The tonnage yields per acre and the analyses of the juice of all these varieties were carefully recorded, and as the results cover a number of years, the conclusions drawn may be considered as fairly reliable. But after many years' growth in their new environment it cannot yet be said that any of these canes are worthy of replacing the varieties at present most widely grown on the plantations. Thus the fact is emphasized that what Louisiana needs is varieties of cane that are particularly suited to its short growing season, and clearly the greater the number that are tried the more likely it will be that one will eventually be found eminently fit.

Fortunately a discovery was made about 1887 which presented an opportunity for the production of an unlimited number of new varieties, inasmuch as about that period Harrison & Bovell in Barbados estab-

* A paper read by Mr. Hamilton Agee before the Louisiana Planters' Association in April last. What follows is abridged from the *Louisiana Planter's* report.

lished the fact of the fertility of sugar cane seed and took useful advantage of this property to produce new and improved strains. Sugar cane, it should be understood, is one of those plants that do not come true to type when grown from seed. The same is true with fruits, such as apples and pears, and also with potatoes and other plants. The seed of Irish potatoes, for instance, will produce many and varied types of potatoes and it is only by planting the eye of the tuber itself, which corresponds to the eyes or buds on the stalk of the cane, that plants in conformity with the parent will be secured. This property of seminal variation, though precluding the propagation of cane commercially from seed, is useful in producing new strains of cane. A vast majority of the new types that are propagated in this manner are wholly inferior to the one which bore the seed. At the same time a few of them are likely to be superior, and it is by the careful selection of these that improvement of sugar cane is possible.

The work of Harrison and Bovell along this line has been marked with the greatest of success. The leading experiment stations and botanical gardens throughout the tropical world instituted like work, and from the thousands of new strains thus originated there have been selected certain of them that have gained wide prominence and have met with such favour as to largely replace in certain countries the varieties that were formerly grown. In some instances the new canes have been adopted for superior tonnage or sugar yields, and in other parts they have gained their way by their disease-resisting properties.

Prompted by the great possibilities presented in this work, the Sugar Experiment Station, as early as 1890, made efforts along this line. As Louisiana cane does not become sufficiently matured to bear arrows or tassels, there was no source of seed at home. Cane seed from the tropics was therefore imported and every effort made to secure germination, but without success. Thinking that the seed became stale in transit, seed bearing varieties were grown under glass in the Audubon Park Horticultural Hall in order to extend the growing period a sufficient length of time for tasselling. Though the canes grew to great lengths, no flowers were formed. The propagation of seedling canes without the tropics therefore seemed hopeless.

The work of securing better strains of cane for the Louisiana fields then resolved itself into making introductions of the seedlings that had been originated elsewhere. Canes from various parts were brought in and tested under local conditions. The first lot was received in 1893, and since that time cuttings from promising seedling canes have from time to time been imported from Java, the Hawaiian Islands, Trinidad, Queensland, Demerara, Barbados and elsewhere.

Among them were the D 74 and D 95. These were among the cuttings to arrive through the courtesy of Professor J. B. Harrison, of Demerara.

After three years' trial on the plots of the experiment station, they showed such favourable comparison over the Purple and Striped canes of Louisiana that a distribution of cuttings to the planters was begun. The wide popularity which these varieties have gained is well known. It is generally recognized that they possess a marked superiority in tonnage and sugar content and other minor characteristics over the older Louisiana canes in nearly every part of the Louisiana sugar belt.

It is nevertheless remarkable that up to this time the Purple and Striped canes since their importation, nearly three-quarters of a century previous, had ranked as the best canes for Louisiana conditions, notwithstanding the many foreign varieties that were meanwhile brought in.

It is likewise important to note that of the many foreign seedlings that have been tested none other than the D 74 and D 95 can receive an unqualified recommendation as being better than the Purple and Striped canes, even though some of them have gained notable reputation in other countries. On the other hand the D 74 and D 95 which with us have proved so satisfactory are not regarded elsewhere as highly as other strains. This is due to the D 74 and D 95 being early maturers, and in a locality where the growing season is of short duration they are particularly desirable. However, where the entire twelve months is available for their development these canes reach maturity in ten months or thereabouts, whereas a more slowly maturing cane utilizes an entire year or eighteen months to reach its maximum development, and in the end gives heavier yields of sugar.

Though the importation of foreign grown seedlings has proved most advantageous in furnishing these two very desirable canes, yet the chance of getting still better varieties appeared ever so much greater if there could be had a wider range of plants from which to select. It was with this in mind that further efforts were made to grow cane from seed in Louisiana. In addition to giving a much larger number to select from than it seemed feasible to import, the propagation of the plants directly from seed in a semi-tropical climate offered the hope of some of them being more likely to become adapted to their environments and hence develop into early maturing types.

As previously stated the first attempt was made in 1890. This was followed by other futile efforts. However, in 1906 success was attained. This was the first time that cane plants were produced from seed beyond the bounds of the tropics.

The method of procedure which was employed then, and which has been utilized in subsequent work, is about as follows: By courtesy the propagating room of the Horticultural Hall of the Audubon Park is utilized for the purpose. A hot-bed is prepared with manure and covered with about two inches of powdered charcoal. Average size pots filled with coarse white sand are placed at a depth of several inches in this bed, and a mass of cane seed placed over this sand in a

layer of about one-half inch in thickness, and kept thoroughly moist. The bed is covered with glass and a temperature of 85-95° F. maintained. A small percentage of seed (if in prime condition) will germinate after about one week. When first sprouted the young plants are so small as to be difficultly visible. The utmost attention is required and the young seedlings must be transplanted about three days after germination. They are placed in small pots with a "starting soil" to induce root development. This soil is found best when prepared from a mixture of one part leaf mould and two parts of finely divided Mississippi river sand, together with about one-fourth of the whole quantity of coarse white sand. These pots with the transplanted seedlings are placed in a frame covered with glass, and a temperature of 70° to 80° maintained. After a few days further development they are transplanted to a richer soil containing more leaf mould. As soon as the plants have attained sufficient size, and weather conditions are such as to endanger no loss from frost, they are set out in the open field. For the first few days strips of cheesecloth are placed to protect the tender plants from the midday sun, and after removing this shelter they receive the cultivation ordinarily given a cane crop. The seed being obtained from the tropics, they usually arrive in mid-winter, and the seedlings which are germinated about February, being very tender, are not entrusted to outdoor temperatures until the latter part of April.

The first year the growth as a rule proves somewhat dwarfed and the sugar content low, the plants presenting little indication of what they will ultimately do. These are harvested about the first of November, and the entire length of the stalk is planted as ordinarily practised in the industry. These produce the second year full sized canes, and it is interesting to note the wide variation in colour, size, sucrose content, and manner of growth.

Canes from the same lot of seed will show the widest contrasts, evidencing seminal variation in the highest degree.

In 1907, the second year of seedling propagation in Louisiana, a number of seedlings was produced derived from cane seed given by the Experiment Station of the Hawaiian Sugar Planters' Association. Out of the quantity that germinated 113 plants survived.

The second year the majority of these canes produced vigorous growers, and the success of producing seedling canes could no longer be doubted. There were two of them, L 100 (derived from D 117), and L 92 (derived from H 39) which gave good promise. The former produced unusually large stalks, some of them weighing from 6 to 8 lbs. apiece. The latter made good growth, and on examination showed a sugar content slightly higher than that of D 74. These canes were therefore watched with great interest, but unfortunately they have gone back. Thus is illustrated the fact that the salient characteristics of seedling canes are not firmly established until after

the lapse of several years. And whereas a cane which appears superior at first may possibly retrogade, it is also posssible for canes holding forth but little during the first year or so afterwards to develop into valuable strains. Thus the greatest care must be exercised in discarding canes as being worthless.

During 1908 a much larger crop of seedlings was propagated, 387 plants in all, derived from Demerara, Trinidad, Barbados, and Hawaiian stock. The following year, 1909, the work was continued. In an effort to secure seed from as wide a range of varieties and localities as possible, letters were addressed to various Government agricultural departments, experiment stations, botanical gardens, sugar companies, &c., throughout the cane-growing world, requesting cane seed for the work in hand. The response was ample, and much appreciation was felt for the co-operation that was given, for without this assistance the work could not have been carried on.

The work undertaken with these gifts amply showed the difficulty of germinating cane seed, for while some lots of seed germinated freely, yet from others no plants at all were obtained. The importance of collecting material from as many and varied sources as is possible cannot therefore be over-emphasized.

It is interesting to note the large number of germinations from seed sent by Mr. Waldron, of Antigua. This is the more worthy of note since the seed of Antigua cane is regarded by the investigators of that Island as being difficult to germinate, the dry climate being supposed to render it much less fertile than seed from the neighbouring islands of the Lesser Antilles. The greater success with this seed than with any from elsewhere may be due to the fact that it was shipped in large bundles and hence kept in better condition than the others which were sent in small packages by mail. Good judgment in selecting seeds in prime condition is also no doubt an important factor.

Eight germinations were obtained from seed received from Australia. Gratification was felt at this, for although the plants did not survive, it nevertheless indicated that the shipment of the delicate seed from such a great distance does not of necessity destroy its vitality, as has heretofore been supposed.

A similarly large assortment of seed was secured for the propagation work of 1910, but though a number of seeds sprouted, yet through unfortunate circumstances none of the plants survived. Handicapped by the necessity of having to grow these plants during the winter months, and it being such a delicate piece of nursery work as to require most precise conditions of temperature, the loss of the entire lot of propagations in certain severe spells of cold weather, when it is hardly possible to control the hot-house conditions to the exacting needs of the tender plants, is a discouragement that must be looked upon as a probability with our present facilities for the work.

In selecting those canes that are best, or rather in discarding those

canes which show no promise, the manner adopted is as follows:—They are grown in a plot of ground which is suitable for a fair comparison; the usual methods of cultivation are applied; at harvest time a careful inspection of the canes is made, and those which are poorest are duly noted. Several stalks of each are taken to the laboratory, the juice extracted by a hand mill and examined for total solids, sucrose and glucose. Where there are several hundred seedlings under examination, this entails much work, but it is of the greatest importance.

From these data the poorest canes can be designated. It is found that those which give the poorest growth are frequently among the lowest in sugar content. As before stated the characteristics are not well fixed until after a number of years, and therefore only the very poorest can be discarded for the first year or two. After the canes have been grown for several years the standards of selection are set higher and all canes which fall below the requirements are dropped from further consideration. Thus the lists of the older seedlings are made smaller each year.

Though it would serve no useful purpose to present here the hundreds of analyses that are comprised in the records of this work, yet several interesting points can be best illustrated by a few quotations.

First, in order to show that this work presents possibilities of originating types of cane of better sugar content than those now cultivated on the Louisiana plantations, it is desirable to call attention to the fact that there were eight of the 1909 seedlings whose juices gave greater percentages of sucrose than the D 74, the figure varying from 11·6 to 13·5, while the contemporary D 74 gave only 11·5. Those canes will be watched with much interest, but too much reliance cannot be placed in them, and at the same time it is by no means unlikely that other of the canes now apparently inferior may develop to be superior to those that now appear to better advantage.

Of the 1908 seedlings there is an even greater number that shows satisfactory sucrose content. Among them the L 511 with a 16·3 per cent. sucrose in its juice is particularly noteworthy. This is an unusually high sucrose content for Louisiana conditions.

Deterioration or improvement in seedlings is probable to occur during the first few years following their propagation. For instance, L 3, which gave only 4·2 per cent. sucrose in 1908, increased to 7·2 per cent. in 1909, and dropped off again to 4·4 in the following year. L 248, which gave 11·5 per cent. sucrose in 1909, dropped to 6·6 per cent. This is a typical instance of a decline in valuable properties. On the other hand, improvement is illustrated in L 267, which gave 6·5 per cent. sucrose in 1908, and shows by the analysis of the following year to have 13·3 per cent. sucrose in its juice. It is interesting to note that these two canes showing opposite tendencies in this par-

ticular characteristic are of the same parent variety, both of them having been germinated from the seed of the T 76.

Other examples of marked seminal variation can be noted nearly all through the work. Take, for example, L 602 and L 662, both seedlings of the same cane, and compare them.

It is noticed that one has a sucrose content of 10·7 and a purity of 69·5, while the other has 2·9 sucrose content and a purity of 33·8. It may also be noticed that one is a green cane and the other a purple one. Such instances of variations are by no means common.

In taking up differences in the size of the stalks and in tonnage yield per acre, variations equally as wide are met.

For many reasons it is inadvisable to publish the tonnage results that have thus far been obtained. With so many seedling strains under observation it has been necessary to confine the space devoted to each of them to a very small fraction of an acre. It has been found, with tests on a larger scale, that calculations of tonnage results from such small areas have often been misleading.

Selections have been made from the best of the strains, taking into consideration the general appearance and laboratory results, and with the larger plots that are being devoted to these canes this season (1911) tonnage results upon which more dependence may be placed will be available by the end of the year. It may, therefore, suffice for the present to say that a number of the seedlings evidence a vigorous growth and give promise of heavy yields. Many of them in this respect show indications of proving superior to the present varieties of the plantations. Naturally the cane which combines the properties of heavy tonnage and rich juice is the one sought, and perhaps the most promising one in this regard at this stage of the work is the L 461, which, with a sucrose content of juice of 12·5, glucose 1·5, and purity 77·2 at an early date in the season, when the D 74 ran 11·5 sucrose, has shown a tonnage yield of 37 tons per acre from the small area that it last year occupied.

The interests of Louisiana should be well aware of the benefits that may accrue from seedling canes, since they have been so fortunate as to secure two such desirable ones from Demerara, but their faith in the ultimate benefits to be had from seedlings will no doubt be strengthened in learning from the late Dr. J. B. Kobus,* of the Experiment Station of Java, that "nowadays in the eastern part of Java, only seedling varieties are cultivated; in the western provinces, where the climate is more favourable for cane culture, the best soils are still used for the old Cheribon cane, but here also the larger part of the soil is planted with seedling canes, and the rapid increase in the Java sugar-production from 2·5 tons per acre in 1887,

*A paper read at the International Congress of Applied Chemistry, London, May-June, 1909. See *I.S.J.*, 1909, 373-379.

to over 4·5 tons of sugar in 1908, is chiefly due to the cultivation of seedling canes."

Throughout the cane growing world a great deal of attention is being devoted to seedlings, much has been accomplished, and even greater benefits are no doubt in prospect.

A continuance of the present work in Louisiana, together with an enlargement of it on a more extensive and comprehensive scale, will in all probability be the means of securing far more desirable strains of early maturing canes than are at present grown on the plantations.

ON THE INFLUENCE OF THE ARROWING OF THE SUGAR CANE ON THE PRODUCTION.*

By R. A. Quintus,
Sempal-Wadak, Java.

Recently Van Vloten (*Archief*, 1910, 279) suggested a further investigation into the question :—"What influence has early or late ripening on the weight and yield of arrowing and non-arrowing canes?" The analyses now published are an attempt to give a conclusive answer to this.

Since in the 1909 research only late ripening varieties were considered, this year four† early and two late ripeners were chosen.

Each sample on the average consisted of 100 canes, which were so taken that one arrowing and one non-arrowing cane were alternately picked from 50 stools. The canes were cut as far under the ground as possible, the non-arrowing varieties being pruned exactly at their vegetation point; while from the arrowing specimens all spongy joints were removed. The samples were taken at month's intervals, and the results are summarized in Table I.

Of the early ripening varieties E. Z. 5a., four kottahs were kept for some months after cutting, so as to give the non-arrowing canes an opportunity to make up for arrears, and it took as long as three months before the yields were the same.

Before coming to the discussion of the results, it should be distinctly pointed out that here work is being carried out under peculiar climatic conditions, so that it is quite possible that similar investigations in other parts may lead to absolutely different results.

So far as length and weight are concerned, the data given in Table II are the average of all analyses taken from the time at which no growth to speak of was noticeable; while as regards production, the data are the results of the last determinations, except in the case

---

*Abridged translation from the *Archief*.

† Only two are dealt with in the tables in this abridged translation.—Ed. *I.S.J.*)

of Batjan, which is the average of the last two. It was taken for granted that there were 50,000 canes to each bouw, and the production is calculated on the results of either arrowing or non-arrowing varieties.

In now discussing separately the different cane varieties, the following points arise :—

E. Z. 5a.—The number of spongy joints was rather great among the arrowing canes, which is sufficiently shown by a decrease in the length of 37 cm. The weight and yield of the non-arrowing canes are considerably less than that of the arrowing specimens, which accounts for the great difference in the production of sugar per bouw.

Yellow Striped Batjan.—Scarcely any withered joints had to be removed. Here the arrowing canes are a little taller than the non-arrowing ones. They are also considerably heavier and higher in rendement, so that they yield altogether 28 picols more sugar per bouw.

G. Z. 100.—In this one also the length of the arrowing canes gradually decreases, whereas that of the non-arrowing specimens steadily increases. In the latter the difference in length even amounted to 88 cm. On account of their greater weight, the non-arrowing canes produced 500 picols more cane, and as the yield is also higher the difference in the production of sugar thus amounts to 90 picols per bouw.

G. Z. 247.—Likewise, with this variety, there is a great difference to be noticed in length, but the weight varies less, so that in this case the non-arrowing canes only yield 21 picols more sugar.

Consequently, with the early ripening varieties, at any rate with those varieties here examined, no harmful influence of arrowing can be established; while with the late ripeners, on the other hand, there is a loss in the production of sugar.

TABLE I.

Name.	Length.	Weight.	Brix.	Sucrose.	Purity.	Glucose.	Glucose Ratio.	Yield.
E.Z. No. 5a.								
April 11th—	Small leaflets preceding the flower entirely developed.							
Arrowing ..	2697	1·522	15·00	11·77	78·46	2·50	21·24	6·82
Non-arrowing ..	2192	1·228	13·90	10·30	74·10	2·95	28·64	5·36
May 12th—	Flowers entirely developed.							
Arrowing ..	2720	1·707	17·36	14·68	84·56	1·98	13·47	9·60
Non-arrowing ..	2592	1·342	15·36	12·43	80·78	2·36	19·00	7·60
June 12th—	Flowers dried up.							
Arrowing ..	2298	1·300	18·10	13·40	84·81	1·35	10·80	12·05
Non-arrowing ..	2461	1·125	15·80	16·58	91·60	0·76	4·59	8·80
July 15th—	Flower stalks fallen off.							
Arrowing ..	2375	1·429	19·40	18·31	94·38	0·32	5·—	13·78
Non-arrowing ..	2703	1·126	17·70	16·—	90·39	0·80	1·20	11·44

Cut July 27th.

Name.	Length.	Weight.	Brix.	Sucrose.	Purity.	Glucose.	Glucose Ratio.	Yield.
E.Z. No. 5a.								
September 6th—								
Arrowing	3487	1·593	20·60	19·79	96·07	0·14	0·71	15·18
Non-arrowing ..	3311	1·766	19·40	18·09	93·25	0·33	1·82	13·42
October 6th—								
Arrowing	2337	1·309	20·—	19·38	96·90	0·22	1·13	15·01
Non-arrowing ..	2815	1·112	20·1	19·37	96·41	0·21	1·07	14·91
Batjan.								
March 12th—	Small leaflets preceding the flower entirely developed.							
Arrowing	1880	0·883	17·50	14·71	84·06	1·10	7·48	9·53
Non-arrowing ..	1550	0·679	15·80	12·53	79·37	1·53	12·21	7·41
April 14th—	Flowers just out.							
Arrowing	2032	1·089	20·50	19·03	92·83	0·45	2·36	14·05
Non-arrowing ..	1811	0·782	18·50	16·38	88·54	0·91	5·55	11·41
May 17th—	Flowers just on the point of withering.							
Arrowing	2127	0·990	21·68	18·79	86·67	0·28	1·49	12·72
Non-arrowing ..	2042	0·879	20·08	16·68	83·07	0·51	3·06	10·62
June 11th—	Flowers dried up.							
Arrowing	1880	0·800	20·80	19·75	94·95	0·34	1·72	14·96
Non-arrowing ..	1834	0·693	19·40	17·86	92·05	0·45	2·52	13·06
July 10th—	Flower stalks fallen off.							
Arrowing	2117	1·081	21·50	20·05	93·26	0·21	1·04	14·88
Non-arrowing ..	2135	0·979	20·35	18·50	90·86	0·53	2·87	13·32
	Cut July 16th.							
G. Z. No. 100.								
March 12th—	Small leaflets preceding the flower entirely developed.							
Arrowing	1870	1·142	13·—	7·73	59·46	4·37	56·53	1·97
Non-arrowing ..	1560	1·036	12·—	6·61	55·08	5·24	79·27	0·97
April 14th—	Flowers entirely developed.							
Arrowing	1871	1·252	14·30	9·66	67·55	2·96	30·74	4·01
Non-arrowing ..	1886	1·190	12·10	7·19	59·42	3·82	53·12	1·82
May 17th—	Flowers dried up.							
Arrowing	1866	1·319	15·76	10·29	65·29	2·79	27·11	3·86
Non-arrowing ..	2306	1·536	14·26	8·18	62·27	3·14	35·36	2·80
June 11th—	Stalks withered.							
Arrowing	1684	1·184	14·—	10·68	76·29	2·21	20·69	5·89
Non-arrowing ..	2404	1·538	14·2	10·81	76·13	2·10	20·—	5·93
July 10th—	Flower stalks fallen off.							
Arrowing	1790	1·328	15·80	12·69	80·32	2·48	19·54	7·66
Non-arrowing ..	2494	1·554	16·80	13·71	81·61	2·93	21·37	8·50
September 4th—								
Arrowing	1652	1·173	18·80	16·80	89·36	0·78	4·64	11·84
Non-arrowing ..	2534	1·457	19·40	18·39	94·80	0·51	2·72	13·90
	Cut September 10th.							
G. Z. No. 247.								
April 9th—	Small leaflets preceding the flower entirely developed.							
Arrowing	2206	15·41	14·20	10·35	72·89	2·34	22·61	5·20
Non-arrowing ..	1717	1·268	12·90	8·98	69·61	2·62	29·10	4·05

Name.	Length.	Weight.	Brix.	Sucrose.	Purity.	Glucose.	Glucose Ratio.	Yield.
G. Z. No. 247.								
May 9th—			Flowers in full bloom.					
Arrowing	2247	1·564	15·80	13·—	82·26	1·72	14·61	8·16
Non-arrowing ..	2079	1·637	13·80	11·17	80·94	1·90	15·40	6·83
June 10th—			Flowers dried up.					
Arrowing	1762	1·278	17·—	14·85	87·34	1·27	8·55	10·16
Non-arrowing ..	2200	1·690	14·80	12·18	82·30	1·72	14·12	7·65
July 12th—			Flower stalks fallen off.					
Arrowing	1842	1·456	16·10	13·64	84·72	1·—	6·52	9·45
Non-arrowing ..	2333	1·680	16·10	13·96	86·71	0·91	7·33	9·02
September 6th—								
Arrowing	1800	1·559	18·60	16·60	89·25	1·05	4·38	11·68
Non-arrowing ..	2265	1·408	19·10	17·14	89·74	0·75	6·33	12·14

Cut September 18th.

TABLE II.

Cane Variety.	Length in Metres.	Weight in Grms.	Weight per Meter.	Picols of Cane per Bouw.	Yield.	Picols of Sugar per Bouw.
Early ripening varieties—						
E. Z. 5a.	2·32	1364	586	1105	13·78	152·3
	2·58	1126	436	912	11·44	104·3
Batjan	2·04	990	486	802	14·92	119·6
	1·95	933	426	695	13·19	91·7
Late ripening varieties—						
G. Z. 100	1·75	1251	716	1013	11·84	120·9
	2·43	1516	623	1516	13·90	210·7
G. Z. 247..	1·80	1431	795	1159	11·68	135·4
	2·26	1593	703	1290	12·14	156·6

As a consequence of the dry weather experienced this summer it is expected that the sugar beet crops of Germany, Austria, and Russia will show a considerable shortage this year. Czarnikow estimates that Germany's deficiency alone will be at least 400,000 tons.

According to a report in the Jamaica press, it is intended to establish cane cultivation in the parish of St. Catherine, Jamaica, and a large central is to be built. The moving spirit in the enterprise is Mr. W. Maxwell, of London, who was formerly connected with the Java sugar industry.

WHOLESALE PRICES OF SUGAR IN PRINCIPAL MARKETS.

The following tables, showing the movement of wholesale prices of sugar in the European markets, also in New York and Montreal, were compiled by the Bureau of Statistics at Washington to present to Senate and are published in Document No. 55 of 62nd Congress. They are preceded by an explanatory memorandum which is given below. Prices as given relate to standard grades of both raw and refined sugars. In the case of raw sugar the prices quoted are so-called "prices in bond", *i.e.*, exclusive of excise or duty, while in the case of refined the prices, unless mention is made to the contrary, include the excise or the import duty.

MEMORANDUM.

A comparison of the raw-sugar prices quoted in the principal European markets shows a fairly close correspondence of quotations at the various markets covered by the tables. The same is true to a large extent also of the prices of refined sugar, if the varying rates of domestic excises are considered, which are levied in the different European countries.

It should be noted that some of the principal European sugar-producing countries, including Germany, Austria-Hungary, France, and Belgium, by international agreement (effective September 1st, 1903), abolished their bounties on sugar and reduced their surtaxes (*i.e.*, the difference between the rates of import duties and those of internal-revenue duties), to 48·2 cents per 100 pounds of raw and 52·5 cents per 100 pounds of refined sugar in accordance with the provisions of the Brussels convention of March 5th, 1902. Germany, France, and Belgium also reduced at the same time the internal-revenue duties (excises) on domestic sugar. The result is seen in the movement of sugar prices for domestic consumption and export beginning with 1903 and 1904.

In Germany, for instance, where the tax on domestic sugar was reduced from 2·16 to 1·51 cents per pound and the tax on imported sugar from 4·32 cents per pound to 1·99 cents per pound of unrefined and 2·03 cents of refined sugar, the annual average price of raw sugar for export at Hamburg rose from 1·42 cents in 1902 (the year preceding the ratification of the Brussels agreement) to 2·13 cents for 1904, 2·53 cents in 1905, and an average of 2·25 cents for the five-year period 1906-1910. On the other hand, the price of refined sugar at Magdeburg, which in 1902 had averaged 6·10 cents per pound, was but 4·30 cents in 1904, 4·64 cents in 1905, and 4·42 cents for the five-year period 1906-1910. French raw sugar in bond averaged 1·59 cents in 1902 and rose to 2·30 cents in 1904 and 2·50 cents in 1905,

while the domestic price of prime refined sugar, owing largely to the change of fiscal treatment (reduction of the internal-revenue tax and of the surtax on imported sugar) fell from 8·30 cents in 1902 to 5·41 cents per pound in 1904 and an average of 5·45 cents for the five-year period 1906-1910. The Government of Austria-Hungary, while abolishing the bounties and reducing the surtax on imported sugar, did not, however, reduce its internal-revenue duties (excises) on consumption sugar. But even these measures, resulting, as they did, in the break up of the sugar cartel, were followed by a considerable decrease in the domestic price of sugar, though the general price movement for the years following 1903 is reflected much more in the upward course of raw sugar prices (for export) than in the downward course of domestic prices of refined sugar.

Prices of sugar for domestic consumption in Russian markets are regulated most effectively by the Government, which fixes the maximum raw sugar prices at the beginning of each season. A comparison of these official maxima and the actual prices in the Kieff market for the last 10 years shows that, on the whole, the latter did not exceed much the uppermost limits set by the Government except during the 1909-10 season, when importations at reduced tariff rates were authorized by the Government. The situation in the world market affects only the export prices of Russian sugar, which vary quite independently of the movement of domestic prices, as may be seen from a comparison of Odessa quotations of export sugar and sugar for domestic consumption. These export prices are invariably lower than the corresponding prices for local consumption by more than the internal-revenue duty of 2·5 cents per pound.

Italian and Spanish refiners, as a rule, are able to maintain prices slightly below the import level; *i.e.*, export prices at the nearest foreign sugar market, plus the high import duty (8·67 cents per pound in Italy and 6·75 cents in Spain). It may be stated in this connection that in the case of Italy the high rates of import duty and surtax (about 2·5 cents per pound) were sanctioned by the Brussels Convention for the time being, so long as the Italian sugar was not exported. The Spanish Government did not ratify the Brussels Convention, and Spanish sugars are subject to a countervailing duty of 2·36 cents per pound when imported into countries adhering to the Brussels Convention.

British import prices for the more recent years of both raw and refined sugars, which in 1902 had fallen as low as 1·56 cents (unrefined beetroot) and 2·24 cents (refined, all other), on the whole show an upward trend, and for the year 1910 were about 20 to 30 per cent. higher than for the year 1902, when the Brussels convention was concluded. Domestic prices, as seen by the quotations for Tate's cubes, follow a similar course, partly in sympathy with the higher prices of raw sugar, partly also by reason of the import duty on

sugar adopted in 1901 (0·905 cent per pound of refined from April 19th, 1901, to May 18th, 1908, and 0·398 cent per pound of refined since). Tate's cubes, No. 2, which averaged 3·15 cents in 1900 (prior to the introduction of the duty), rose to 3·66 cents in 1901, and to 4·13 cents and 4·61 cents per pound in 1904 and 1905, the years following the ratification of the Brussels Convention. The lowering of the import duty in May, 1908, from 0·905 cent to 0·398 cent per pound of refined affected but slightly domestic prices, because of the simultaneous rise in the price of unrefined sugar during that year.

New York quotations of standard grades on the whole show the same course of development. In the case of Cuban sugar the reciprocity concessions (0·337 cent per pound on 96° centrifugals) are followed by a rise of the annual average price of that grade of sugar (c. and f. price at New York without duty) from 2·035 cents for 1903 to 2·626 cents for 1904. Since then the quotations, as given by Messrs. Willett & Gray, have followed fairly closely the developments in the world market. The price of refined granulated sugar which averaged 4·455 cents in 1902 and 4·638 cents in 1903 (at the end of which year reciprocity with Cuba went into effect), rose during the next years, when prices of the raw product went up, and fell in 1906, when there was a decrease in the price of the unrefined article. The 1910 average price of refined shows an increase over the 1909 average of 0·207 cent per pound, as against an increase of 0·181 cent in the price of the unrefined product (96° centrifugals) for the same year.

Attention is also called to the tables showing the official average monthly and yearly quotations at Habana, Cuba, of 96° and Muscovado sugars for the period of 1904 to 1909, and the comparative prices of these sugars at Habana and New York for the same years.

Germany.

Average yearly Prices during calendar Years 1901 to 1910, of Raw Sugar (in bond) and Refined Sugar (excise free), at Magdeburg, Germany.

[From the Quarterly of the German Imperial Statistical Office.]

	Raw, first product, 88 % at Magdeburg.*		Refined, lump, at Magdeburg.†	
	Per 100 kilos. Marks.	Per lb. Cents.	Per 100 kilos. Marks.	Per lb. Cents.
1910	24·59	2·65	47·36	5·11
1909	21·20	2·29	41·70	4·50
1908	20·60	2·22	40·80	4·40
1907	16·80	1·81	38·30	4·13
1906	16·70	1·80	36·80	3·97
1905	22·40	2·42	43·00	4·64
1904	19·90	2·15	39·80	4·30
1903	18·00	1·94	53·30	5·75
1902	15·30	1·65	56·50	6·10
1901	19·10	2·96	57·90	6·25

* Exclusive of bag; terms, three months. † Exclusive of barrel.

Hamburg.

Annual Averages for calendar Years 1901 to 1910, of Hamburg f.o.b. Prices of 88 per cent. Raw Sugar and of First Marks Granulated.*

[From Willett and Gray's Weekly Statistical Sugar Trade Journal.]

	Raw, 88 %				First Marks Granulated.		
	Per 112 lbs.		Per lb.		Per 112 lbs.		Per lb.
	s.	d.	Cents.		s.	d.	Cents.
1910	12	10	2·78	....	15	2	3·31
1909	10	9¾	2·34	....	12	10⅞	2·79
1908	10	3½	2·22	....	12	2½	2·64
1907	9	5	2·04	....	11	0¾	2·39
1906	8	6¾	1·85	....	10	7¼	2·29
1905	11	8¼	2·53	....	13	9	2·97
1904	9	10	2·13	....	11	8½	2·54
1903	8	3½	1·79	....	9	8¾	2·10
1902	6	6¾	1·42	....	8	2¼	1·78
1901	8	7½	1·88	....	10	5½	2·28

Austria.

Average yearly Prices (in bond) of Raw and Refined Sugar during calendar Years 1901 to 1910.

[From annual supplements to the Vienna Wochenschrift für Rübenzucker-industrie.]

	First product, B, 88% f.o.b. Aussig, cash.			Prime Centrifugal pilé f.o.b. Trieste, transit cash.	
	Per metric quintal. Kronen.	Per lb. Cents.		Per metric quintal. Kronen.	Per lb. Cents.
1901	22·56	2·08	....	25·08	2·31
1902	18·28	1·68	....	19·80	1·82
1903	21·21	1·95	....	23·61	2·17
1904	23·75	2·19	....	29·85	2·75
1905	26·12	2·41	....	33·09	3·05
1906	19·55	1·80	....	26·26	2·42
1907	21·72	2·00	....	27·55	2·54
1908	23·78	2·19	....	28·79	2·65
1909	24·96	2·30	....	31·05	2·86
1910	29·50	2·72	....	36·73	3·38

Average yearly Prices for the Seasons 1901 to 1910, of Raw Sugar (in bond) and Refined Sugar (excise paid).

[From Wochenschrift des Zentralvereins für die Rübenzuckerindustrie, Vienna, November 2nd, 1910. App.]

	First product, Aussig landing, 88 %			Prime refined, Vienna.			Prime centrifugal pilé transit, Trieste.	
	Per metric quintal Kronen.	Per lb. Cents.		Per metric quintal. Kronen.	Per lb. Cents.		Per metric quintal. Kronen.	Per lb. Cents.
1909-10	31·03	2·86	....	80·67	7·43	....	37·28	3·43
1908-9	23·46	2·16	....	74·38	6·85	....	29·71	2·74
1907-8	23·66	2·18	....	74·00	6·81	....	29·42	2·71
1906-7	21·40	1·97	....	69·03	6·36	....	27·95	2·57
1905-6	19·08	1·76	....	63·25	5·82	....	26·75	2·46
1904-5	29·81	2·74	....	76·09	7·01	....	36·31	3·34
1903-4	20·59	1·90	....	68·10	6·27	....	26·48	2·44
1902-3	20·92	1·93	....	84·92	7·82	....	21·99	2·02
1901-2	18·85	1·74	....	84·87	7·81	....	21·92	2·02
1900-1	25·23	2·32	....	84·87	7·81	....	27·43	2·53

* Cash, less 2 months' interest at 5 per cent. per annum.

France.

Annual average Prices of Sugar in Paris for the Years 1901 to 1910.

[From the *Journal des Fabricants de Sucre* and the *Liste Génerale des fabriques de sucre.*]

	Raw, 88° (in bond).		White No. 3 (in bond).		Refined in loaves, excise paid.			
					Prime.		Good.	
	Per 100 kilos.	Per lb.	Per 100 kilos.	Per lb.	Per 100 kilos.	Per lb.	Per 100 kilos.	Per lb.
	Francs.	Cents.	Francs.	Cents.	Francs.	Cents.	Francs.	Cents.
1910 ..	35·89	3·14	39·98	3·50	72·10	6·31	71·60	6·28
1909 ..	28·60	2·50	31·82	2·79	62·57	5·48	62·07	5·43
1908 ..	27·21	2·38	30·21	2·64	60·98	5·34	60·48	5·29
1907 ..	23·97	2·10	26·68	2·34	57·64	5·05	57·14	5·00
1906 ..	22·62	1·98	25·78	2·26	57·76	5·06	57·26	5·01
1905 ..	28·53	2·50	32·44	2·84	66·23	5·80	65·73	5·75
1904 ..	26·24	2·30	29·47	2·58	61·77	5·41	61·27	5·36
1903 ..	22·21	1·94	25·47	2·23	82·00	7·18	81·50	7·13
1902 ..	18·11	1·59	22·18	1·94	94·81	8·30	94·31	8·26
1901 ..	22·52	1·97	26·08	2·28	100·33	8·78	99·83	8·74

Russia.

Market Prices of "sand" sugar at Kiev and Maximum Prices as fixed by the Russian Committee of Ministers.

[From the Viestnik Finansov.]

	For the period September-December.				For the period January-August.			
	Market prices.		Official maxima.		Market prices.		Official maxima.	
	Per pood.	Per lb.	Per pood.	Per lb.	Per pood.	Per lb.	Per pood.	Per lb.
	Kopecks.	Cents.	Kopecks	Cents.	Kopecks.	Cents.	Kopecks	Cents.
1900–1901	422–428	6·02–6·10	440	6·27	444–456	6·33–6·50	455	6·49
1901–2 ..	423–429	6·03–6·12	435	6·20	418–451	5·96–6·43	450	6·42
1902–3 ..	411–422	5·86–6·02	430	6·13	410–440	5·85–6·27	445	6·35
1903–4 ..	403–418	5·75–5·96	420	5·99	422–433	6·02–6·17	435	6·20
1904–5 ..	410–425	5·85–6·06	420	5·99	410–445	5·85–6·35	435	6·20
1905–6 ..	410–431	5·85–6·15	415	5·92	410–440	5·85–6·27	435	6·20
1906–7 ..	407–423	5·80–6·03	415	5·92	391–408	5·58–5·82	430	6·13
1907–8 ..	375–395	5·35–5·63	415	5·92	378–410	5·39–5·85	430	6·13
1908–9 ..	392–405	5·59–5·78	410	5·85	407–427	5·80–6·09	420	5·99
1909–10..	405–417	5·78–5·95	410	5·85	416–457	5·93–6·52	420	5·99
1910–11..	382–407	5·45–5·80	410	5·85	....	....	420	5·99

Domestic Prices of Sugar at St. Petersburg and Odessa and Export Prices of Sugar at Odessa for the calendar Years 1900 to 1910.

[From the Monthly and Annual Trade Statistics of the Russian Empire.]

	St. Petersburg.				Odessa.			
					Unrefined "sand" sugar.			
	Unrefined ("sand").		Refined ("Koenig privil.")		For local consumption.		For export.	
	Per pood.	Per lb.	Per pood.	Per lb.	Per pood.	Per lb.	Per pood.	Per lb.
	Roubles.	Cents.	Roubles.	Cents.	Roubles.	Cents.	Roubles.	Cents.
1900 ..	....	....	....	....	4·66	6·65	1·62	2·31
1901 ..	5·10	7·27	6·10	8·70	4·67	6·66	1·56	2·22
1902 ..	4·95	7·06	5·83	8·31	4·53	6·46	1·25	1·78
1903 ..	4·92	7·02	5·67	8·09	4·48	6·39	1·30	1·85
1904 ..	4·92	7·02	5·85	8·34	4·53	6·46	1·63	2·32
1905 ..	4·96	7·07	6·05	8·63	4·50	6·42	2·08	2·97
1906 ..	4·89	6·97	5·98	8·53	4·41	6·29	2·41	3·44
1907 ..	4·66	6·65	5·48	7·81	4·17	5·95	1·58	2·25
1908 ..	4·61	6·57	5·43	7·74	4·16	5·93	1·62	2·31
1909 ..	4·85	6·92	5·77	8·23	4·41	6·29	1·87	2·67
1910 ..	4·86	6·93	5·45	7·77	....	....	....	....

ITALY.

Prices of Refined Sugar "Nazionale extra" in Genoa, 1908 and 1909.

[From *La Riforma Sociale.* Marzo-Giugno, 1910.]

	1908.		1909.	
	Per 100 kilos. Lire.	Per lb. Cents.	Per 100 kilos. Lire.	Per lb. Cents.
Average..	131·27 ..	11·49 ..	132·45 ..	11·60

SPAIN (BARCELONA).

Sugar Prices, average yearly, 1902 to 1909.

[From Memorias sobre el Estado de la Renta de Aduanas, 1902 to 1909.]

	Beet sugar.				Cane sugar.			
	Centrifugals.		Prime granulated.		Centrifugals.		"Blanquillo."	
	Per 100 kilos.	Per lb.	Per 100 kilos.	Per lb.	Per 100 kilos.	Per lb.	Per 100 kilos.	Per lb.
	Pesetas.	Cents.	Pesetas.	Cents.	Pesetas.	Cents.	Pesetas.	Cents.
1909..	115·36	9·16	120·45	9·56	119·65	9·50	119·73	9·50
1908..	114·94	8·91	118·94	9·22	114·74	8·90	118·53	9·19
1907..	102·90	8·07	107·80	8·46	106·86	8·39	107·35	8·42
1906 .	97·27	7·54	100·80	7·82	98·80	7·66	98·71	7·66
1905..	103·05	6·87	106·38	7·09	104·25	6·95	102·68	6·85
1904..	103·05	6·54	111·45	7·08	111·21	7·06	111·02	7·05
1903..	100·58	6·52	109·93	7·13	102·85	6·67	108·02	7·01
1902..	94·59	6·09	106·70	6·87	99·50	6·41	102·75	6·62

United Kingdom.

Average Yearly Import Prices of Unrefined and Refined Sugar during the calendar Years 1900 to 1909.

[From the Statistical Abstract for the United Kingdom.]

Years.	Refined.				Unrefined.			
	Lump or loaves.		All other including candy.		Beetroot.		Cane and other sorts.	
	Per cwt.	Per lb.	Per cwt.	Per lb.	Per cwt.	Per lb.	Per cwt.	Per lb.
	Shillings.	Cents.	Shillings.	Cents.	Shillings.	Cents.	Shillings.	Cents.
1900..	13·79	3·00	12·65	2·75	10·00	2·17	12·00	2·61
1901..	13·43	2·92	11·97	2·60	9·06	1·97	10·92	2·37
1902..	11·94	2·59	10·29	2·24	7·16	1·56	8·77	1·91
1903..	12·11	2·63	10·48	2·28	8·44	1·83	9·27	2·01
1904..	13·23	2·87	12·08	2·62	10·07	2·19	10·30	2·24
1905..	16·31	3·54	14·58	3·17	10·68	2·32	12·94	2·81
1906..	12·54	2·72	11·38	2·47	8·81	2·91	9·34	2·03
1907..	13·02	2·83	11·81	2·57	9·61	2·09	10·14	2·20
1908..	14·02	3·05	12·76	2·77	10·53	2·29	10·89	2·37
1909..	14·53	3·16	13·15	2·86	11·16	2·42	11·00	2·39

Prices of Refined Sugar in London; yearly Averages for calendar Years 1900 to 1910.

[Compiled from weekly quotations in the *International Sugar Journal.*]

	Tate's cubes, No. 1.			Tate's cubes, No. 2.		
	Per cwt.		Per lb.	Per cwt.		Per lb.
	s.	d.	Cents.	s.	d.	Cents.
1910..	21	5·97	4·67	20	8·99	4·51
1909	19	4·44	4·21	18	5·56	4·01
1908..	19	3·40	4·19	18	5·61	4·01
1907	19	6·66	4·25	18	7·50	4·05
1906..	18	9·03	4·07	17	9·66	3·87
1905	22	·11	4·78	21	2·88	4·61
1904..	19	10·07	4·31	19	·32	4·13
1903	18	2·71	3·96	17	4·90	3·78
1902..	17	4·07	3·77	16	4·99	3·57
1901	17	11·94	3·91	16	10·38	3·66
1900..	16	3·37	3·54	14	6·09	3·15

United States.

New York Prices of Raw and Refined during calendar Years 1901 to 1910; terms, net cash.

[From Willett & Gray's *Statistical Sugar Trade Journal.*]

	89° Muscovado, per lb. (including duty).	96° centrifugal, per lb. (including duty).	96° centrifugal Cuban sugar, per lb. (without duty).	Granulated in barrels per lb.
1901	3·527	4·047	2·362	5·050
1902	3·035	3·542	1·857	4·455
1903	3·228	3·720	2·035	4·638
1904	3·470	3·974	2·626	4·772
1905	3·694	4·278	2·918	5·256
1906	3·183	3·686	2·316	4·515
1907	3·248	3·765	2·396	4·649
1908	3·573	4·073	2·713	4·957
1909	3·507	4·007	2·646	4·765
1910	3·688	4·188	2·828	4·972

Average yearly Prices at Habana, Cuba, of Raw Sugar during the calendar Years 1904 to 1909.

[From the *Industria Azucarera* of the Cuban Secretaria de Hacienda.]

	96° Centrifugal.		Muscovado.	
	Centavos per arroba.	Cents per lb.	Centavos per arroba.	Cents per lb.
1904	63·022	2·292	45·906	1·669
1905	69·899	2·542	52·286	1·902
1906	52·956	1·926	34·856	1·267
1907	55·932	2·034	36·295	1·320
1908	64·091	2·331	45·864	1·668
1909	62·643	2·278	45·808	1·666

Comparative average yearly Prices of 96° Centrifugal and Muscovado Sugars at Habana, Cuba, and New York, for the calendar Years 1904 to 1909.

[Based on quotations of the *Industria Azucarera* of the Cuban Secretaria de Hacienda.]

	96° Centrifugal.*		Muscovado.†	
	New York. Cents per lb.	Habana. Cents per lb.	New York. Cents per lb.	Habana. Cents per lb.
1904	3·920	2·292	3·459	1·669
1905	4·268	2·542	3·683	1·902
1906	3·692	1·926	3·190	1·267
1907	3·764	2·034	3·242	1·320
1908	3·915	2·331	3·431	1·668
1909	3·994	2·278	3·499	1·666

* Duty on Cuban 96° centrifugals = 1·685 cents per lb., less 20 per cent. = 1·348 cents.

† Duty on Muscovados 89° polarization = 1·440 cents per lb., less 20 per cent. = 1·152 cents.

CANADA.

Annual Prices of Sugar (in barrels) at Montreal during the calendar Years 1900 to 1910. (Cents per lb.)

	Montreal. yellow.		Montreal granulated.		Montreal extra granulated.
1900	3·81	....	4·19	....	4·75
1901	3·89	....	4·29	....	4·50
1902	3·22	....	3·50	....	3·80
1903	3·11	....	3·48	....	4·00
1904	3·52	....	3·99	....	4·41
1905	4·19	....	4·64	....	5·13
1906	3·40	....	3·83	....	4·20
1907	3·68	....	4·00	....	4·38
1908	3·89	....	4·25	....	4·63
1909	4·03	..	4·21	....	4·61
1910	....	....	....	....	4·96

NOTE.—Prices of "granulated" and "yellows" are based upon quotations given in the "Wholesale Prices in Canada," Prices of "extra granulated" are based upon quotations of Messrs. Willett & Gray.

JAVA.

Prices of Java Sugar afloat, No. 15 Dutch Standard (96° test). United Kingdom Terms.

[From Willett & Gray's *Statistical Sugar Trade Journal.*]

	Per cwt. s.	d.		Per lb. Cents.		Per cwt. s.	d.		Per lb. Cents.
1910..	13	4	..	2·90	1904	10	9	..	2·34
1909	11	8¼	..	2·54	1903..	9	7¼	..	2·09
1908..	11	4¾	..	2·48	1902	8	3	..	1·79
1907	10	5	..	2·26	1901..	10	9¾	..	2·35
1906..	9	8	..	2·10	1900	12	6	..	2·72
1905	12	8½	..	2·76					

SATURATION RATIOS OF SUGAR SOLUTIONS, AND THEIR DETERMINATION.*

By Dr. H. CLAASSEN.

The saturation ratios of pure and impure sugar solutions have already often been investigated. Although for pure solutions, through the experiments of Herzfeld, there exist figures which are recognised as correct, for impure solutions values of general applicability are still wanting. For some years past, I have determined the saturation ratios of syrups and molasses in the crystallization apparatus designed by Herzfeld. The results quite suffice as a basis for practical crystallization; but do not yet allow of the deduction of a generally applicable law, as, *e.g.*, the dependence of the saturation values on the purity. Hence, so far, I have refrained from publication.

If, nevertheless, I now briefly consider saturation ratios and their determination, it is because of an article by Koydl entitled "The

*Translated from *Die Deutsche Zuckerindustrie*, 1911, *36*, 554-555.

Occurrence of Apparently Subsaturated Syrups in Beet and Colonial Sugars" (*Österr.-Ungar. Zeitsch. Zuckerind.*, 1911, *40*, 459). This article has as its principal purpose the refutation of objections raised by me against the author's method of determining the crystal content of raw sugars (*cf.* Koydl, this *Jl.*, 1909, 204, 206; and 1910, 260), and especially of giving an explanation of the low saturation values found for the syrup adhering to the crystals. Upon Koydl's method I will not here dwell, since, so far, it has no practical signification, and in my opinion never will have. To my knowledge no refinery has gone further than making experiments, not even the Halle Refinery, although von Lippmann appears sympathetic towards the method.

As to the saturation ratios of the syrup adhering to raw sugar, experiments by Politzer with Koydl's method (*Österr.-Ungar. Zeitsch. Zuckerind.*, 1908, *37*, 30) show that in many sugars there are syrups of a purity of 60°, and even less, in which to one part of water only 1·54, 1·55, 1·70, 1·74 or 1·82 parts of sugar are dissolved; whereas in a pure saturated sugar solution to one part of water, at 0° C. 1·79, at 10° C. 1·90, and at 20° C. 2·04 parts of sugar are dissolved; and in a saturated molasses-like syrup of 60 purity, in which more sugar to one part of water is dissolved than in pure solutions, there are at 0°C. about 2·0, at 10° C. about 2·1, and at 20° C. about 2·2 parts of sugar. The explanation hitherto advanced for these low content figures, viz., errors of analysis, which are unavoidable and strongly influence the result, and the precipitation of sugar by the action of the wash-liquors (this *Jl.*, Ehrlich, 1910, 97), Koydl will not accept; and in order to save his method he maintains in his latest article that the syrup adhering to the crystals during the storage of raw sugar crystallizes out so far that the saturation ratio of a pure sugar solution at the lowest storage temperature is reached, while with increase of temperature sugar is not dissolved, or is only to a very small extent, so that actually a subsaturated syrup adheres to the crystals.

This hypothesis is, however, false, and is the result of ignorance of the literature of saturation ratios, and of experiments incorrectly carried out. Koydl first affirms that the degree of saturation of sugar solutions differs "according as they result from supersaturation or from subsaturation;" and then he adds, "as is well known, Herzfeld's table on the solubility of sugar is derived from fundamental figures obtained by shaking-out supersaturated solutions." When the phrase "as is well known" appears, one may be suspicious; and on consulting the original paper it is found that this mistrust is justified. Herzfeld (*Zeitsch. Ver. deut. Zuckerind.*, 1892, 232) in his fundamental experiments worked with both supersaturated and subsaturated sugar solutions, and says expressly "if the experimental conditions are correct, in both cases, whether by crystallizing out or by re-dissolving sugar, the same result should be obtained" (page 234).

Herzfeld is thus of the opinion that the degree of saturation of sugar solutions does not differ whether subsaturated or supersaturated solutions be initially used; and indeed even says (*ibid.* 764) "that it is easier in an agitation apparatus to make a subsaturated into a saturated solution by dissolving sugar, than to obtain a saturated from a supersaturated by crystallizing out sugar, more especially in the case of impure solutions." Thus part of Koydl's explanation collapses.

In what concerns his experiments, they were performed without any crystallizing apparatus, and therefore without exact regulation of the temperature and continuous agitation. Herzfeld formed saturated solutions from both subsaturated and supersaturated solutions within 4 to 5 hours; whereas Koydl did not succeed in bringing his subsaturated solutions to saturation point in 7 to 12 days. In addition to his incomplete experimental arrangements, the small amount of inciting crystal remaining after reaching any degree of saturation is to be blamed for these results.

Moreover, Koydl's experimental conditions do not correspond in any way to those obtaining in raw sugar. In his experiments, to one part of sugar solution there was only 0·02 and 0·25 of a part of crystal; whilst in raw sugar to one of syrup about 9 parts of crystal are present. In raw sugar, therefore, there are 36 to 450 times as much inciting crystal present as in Koydl's experiments, and 30 times as much as in Herzfeld's. On account of this large amount of inciting crystal, the continuous motion that is wanting in the case of raw sugar is compensated, so that the subsaturation of the adhering syrup must be destroyed in a few hours, if not entirely, at any rate for the greater part. When, therefore, on crystallizing out, an only saturated syrup forms in a raw sugar containing plenty of water, and stored at 0° C., a sample of this sugar will contain a syrup after keeping for a few hours at 20° C., which has dissolved so much sugar from the crystal as to be approximately saturated. Since now the sugar tested by Koydl was not directly examined at the temperature of the store, but after keeping for some time in a heated room, there remains as explanation of the low sugar content values of the syrup simply the defectiveness of the method employed. This explanation is the more probable since a considerable number of the figures for the sugar content lie even lower than the saturation value of molasses-like syrups at 0° C.

Into Koydl's experiments on colonial sugars, I do not require to go, after what has been said above. Experiments on the conditions of saturation in cane sugars, *i.e.*, sugars containing invert sugar, demand first of all a fully efficient crystallization apparatus, and it seems to me to be desirable that the experiments should be repeated in an approved manner before it can be decided whether Koydl or Prinsen Geerligs is right.

Cuba.

The British Consul in Cuba in the course of his 1910 Report states:—

The sugar crop of 1909-10 season amounted to 1,800,000 tons, or 100,000 in excess of the estimates. The following is a comparative table of the crops during the past two years:—

Year.	Mills operating.	Canes ground.	Percentage of Sugar.	Sugar.	Molasses.
1909	170	13,951,998	10·90	1,521,818	60,331,307
1910	175	16,173,378	11·23	1,817,544	74,011,482

Trustworthy estimates of the production of sugar for the 1910-11 season set the figure at 12,241,000 bags (about 1,750,000 tons). The accuracy of these figures, based on the working of 170 mills now in operation, depends on the continuance of favourable weather during the cutting season, which extends from December until June. It is not anticipated, however, that the price will reach the high figure of the past season, the shrinkage in value being estimated at £4,000,000.

The estimated amount of sugar grown for home consumption for the past three years is:—1907, 62,827 tons; 1909, 69,706 tons; 1910, 71,185 tons.

Of the remainder almost the entire amount is exported to the United States, and, indeed, the sugar industry of Cuba is slowly passing into foreign, principally United States, hands.

The trade with the United States is fostered by the Reciprocity Treaty between the two countries, by which Cuban sugar imported into the United States receives preferential treatment. The American Sugar Trust controls a number of important plantations in the islands.

A certain number of refineries have been established, and that branch of the industry is now practically in a position to supply local requirements, as is revealed by the statistics of the importation of refined sugar, which show a decrease in imports from 8,227 cwts. in 1905 to 425 cwts. in 1910.

The average retail prices in Cuba for the year 1910 were for the white granulated sugar 3¼d. per lb., and for the second quality sugar 2d. per lb. The average price for molasses at the mill during the same period was 1·70d. per gallon. The average wholesale price of sugar of the standard grade of 96 test, warehoused for export, for the past three years has been:—1908, 11s. 6d. per cwt.; 1909, 10s. 6d. per cwt.; 1910, 11s. 4½d. per cwt.

The exportation to the United Kingdom has increased from none in 1908 to no less than 119,418 cwts. from the 1909-10 crop. This was probably due to the shortage in the European beet sugar crop, and a corresponding increase is not anticipated in the exportation of the present year.

Canada is making a bid for Cuban sugar, and the Legislature of that country have made a provision allowing Canadian refineries to import Cuban sugar up to 20 per cent. of their total output on the same terms as sugar from the British West Indies.

During the month of March, in order to bring the country into line with the requirements of the Brussels Sugar Convention of 1902, the Cuban Government reduced the import duties on raw sugar to 1 dol. per 100 kilos., and on refined sugar to 75 c. per 100 kilos. The question was one of vital

importance to the Cuban sugar industry, which, although chiefly dependent on the United States market, is able to deal, so long as the European market is open, at the price fixed in that market.

The industry is in a thoroughly thriving condition. The soil is of such fertility that the canes will continue productive without renewal for a period unknown in other countries, and the industry is consequently of such a profitable nature that foreign capital is very readily attracted to it.

The prosperity produced by the recent crops has caused large purchases of modern machinery, which lead to great economies in production and consequently increased profits. There are still profitable openings in this industry for British labour and capital—at present there are only five or six British plantations in the whole island.

The average production per acre is 12 bags, or 3,900 lbs. The usual course with planters is to arrange with a mill to take their cane, receiving in return 55 to 60 per cent. of the value of the sugar produced therefrom. This averages £10 to £12 per acre. The remainder together with the second grade sugar and the molasses goes to the mill. The ploughing for spring sowing is done in January, February, and March, and the planting in April and May, and the Autumn planting in August or September. Satisfactory sugar land may still be bought at £4 to £10 per acre.

A subsidiary cultivation that has made some progress in Cuba is that of sisal or henequen, which produces a coarse kind of fibre. Its cultivation has indeed advanced so far that a Cuban company has recently applied to the Government for a concession for the manufacture of sugar bags. These are at present imported into the country to the extent of 15,000 tons and of the value of £310,000 annually. Of this total 90 per cent. is made in six factories in Calcutta, and the remaining 10 per cent. at Dundee, the whole amount being transported in British ships.

Portugal.

The imports of sugar from Madeira and the provinces of Mozambique and Angola into Portugal supply the greater part of the home demand; formerly all sugar came from Brazil and British colonies, but now even the import of Continental beet sugar is very much reduced. Beet sugar is produced in one large factory in the Azores, but comparatively little comes to Portugal itself. There are two refineries at Lisbon which work up crude Mozambique sugar, and four in Angola, the output of which is increasing rapidly. The sugar as produced is of good quality, but by the time it reaches the consumer it is a very inferior article and extremely expensive; the present retail price, for instance, of kitchen sugar is 240 reis per kilo. (about 6d. per lb.).

Brazil.

Sao Paulo.—The British Consul reports on the year 1910 as follows:—

The sugar industry is one of the oldest in the State of Sao Paulo, dating from the year 1532. Up till the year 1840 sugar occupied an important place amongst exports from this State; but from that date onwards the export of sugar declined in favour of coffee, and finally ceased altogether to figure amongst the exports.

The output of sugar in Sao Paulo at the present time amounts to some 16,000 tons annually. That amount is much less than the local consumption,

which amounts to some 73,000 tons of sugar annually. The difference, amounting to some 57,000 tons, is imported from Pernambuco, for which State Sao Paulo constitutes the principal market for its sugar.

There exist in the State of Sao Paulo 13 large sugar factories, all of which show handsome profits.

It will be evident from consideration of the fact that the demand for sugar in Sao Paulo exceeds the local production thereof by 57,000 tons annually, that the establishment in the State of other sugar factories would constitute a safe and attractive opening for investment of capital.

This is a point worthy of attention upon the part of British capitalists. I may mention that the largest sugar factory in Sao Paulo belongs to a French company. Most of the plant installed in the various sugar factories in this State is of French manufacture.

Madeira.

As anticipated in my report for 1909 (writes the Consul in Madeira), the crop in 1910 was larger than in any previous year. Some 35,000 to 36,000 tons of cane were used for sugar, as compared with 33,000 tons in 1909. The increase in quantity used for sugar, however, is no criterion of the actual advance in quantity grown, as the British sugar factory commenced operations late in the season in consequence of the delay in the promulgation of a new law which would have overcome the difficulties referred to in my last report. There was, therefore, an unusually large proportion of cane used in the manufacture of brandy by the small mills.

It is calculated that the total crop was about 68,000 tons, with a value of about £245,000. The cane growers are yearly becoming fully alive to the advantages of employment of chemical manures in the cultivation of their cane, and an ever-increasing quantity is being demanded. The ingredients for the manures are imported from the United Kingdom (sulphate of ammonia), Germany (sulphate of potash), and Portugal (superphosphate of lime).

The working capacity of the British sugar factory was once more increased, so that although crushing operations were late in commencing, they were completed at an earlier date than in 1909. The overhead ropeway from the seashore to the mill gave excellent results. The difficulties referred to in my last report have been satisfactorily settled.

PUBLICATIONS RECEIVED.

De Rietsuikerindustrie in de Verschillende Landen van Productie. (The Cane Sugar Industry in Different Countries.) An historical, technical, and statistical review of the production of cane sugar. By H. C. Prinsen Geerligs. XVII. + 416 pages. Published by J. H. De Bussy, Amsterdam. 1911.

Cane sugar technologists are already considerably indebted to Mr. H. C. Prinsen Geerligs for several standard works; but they are

now placed under further obligation to that eminent specialist by the publication of another book, which must be regarded as unique, in that it fills a distinct vacancy in the literature of the subject, now becoming quite voluminous. In his new Dutch work, Mr. Geerligs has set himself the arduous task of writing a history of our industry from its earliest days to the present time, as well as of giving an account of the present position of the industry in every cane sugar producing country of the world. It is not our purpose at present to enter into a discussion in detail of the interesting contents, as arrangements have already been made for the publication of an English edition early in 1912, and a more adequate review will be attempted at a later date. It may, however, be stated here, that Mr. Geerligs divides his matter into two sections. In the first, which is entitled "General History of the Cane Sugar Industry" he records the development of the manufacture of cane sugar from the most remote times to the present date, and describes the effect of the rise of the beet industry upon that of cane, lastly giving an account of the introduction and abolition of the bounty system. In the second part, which takes up the greater part of the book, and is entitled "Position of the Cane Sugar Industry in the Different Countries in which it is Produced," we have a statement of the geographical situation, the climate, the present mode of cane culture, the technical methods used, the fiscal regulations, the consumption, the exports, and the probable future of the industry of every cane growing country in the world. It is only necessary to add that the volume is rendered complete by a number of interesting figures and plates, and that maps of the most important countries are included in the text.

L'Année Sucrière, 1909-1910. Revue générale annuelle des progrès réalisés dans l'industrie du sucre en France et à l'etranger. By R. Teyssier. Première année. Published by H. Dunod et E. Pinat, 47-49, Quai des Grands-Augustins, Paris (VI[e]). 1911. Price unbound, 12 fr. 50.

This is a book which we feel sure will be cordially welcomed by sugar technologists. It is a concise and systematic review, in the form of abstracts from the different sugar journals, of the progress made in every branch of the industry during the period 1909-1910. It is well illustrated, and is provided with a good index. According to the subjects treated, the matter is divided into the 14 following sections, which are again suitably sub-divided:—(1) Soil, manures, and seed; (2) culture, development, and composition of the beet and cane; (3) preparation for manufacture (*i.e.*, siloing and cleaning); (4) extraction of the juice; (5) clarification and treatment of the juice; (6) evaporation and concentration of the juice, and treatment of the syrups; (7) crystallization and separation of the sugar; (8)

treatment of after-products, storage of sugar, and rendements; (9) by-products of manufacture (pulp, bagasse, scums, molasses, &c.); (10) refining of raw sugar; (11) confectionery, preserve, and baking industries, &c.; (12) laboratory apparatus, new chemical methods, and chemical control; (13) patents relating to the sugar industry; and (14) statistics, legislation, &c. From this syllabus, it will be seen that the book follows much the same lines as the well-known German *Jahres-Bericht* of Stammer. On the whole, M. Teyssier has made an excellent review, and has regulated the length of the abstracts with due regard to their technical importance. In future years, however, we should like to see matter dealing with cane sugar receive as full treatment as that relating to beet sugar, for it is noticeable that a number of important papers, published during 1909-1910, dealing with cane technology have escaped notice. It may also be mentioned that in every case references should be given to the original source, and not to translations or notices appearing in other journals, it being apparent that the author has relied in several instances on a French contemporary for interesting papers which first appeared in the columns of this *Journal*. Another point is that the statistical section should be extended. As M. Teyssier writes of the progress made in other countries as well as in France, the statistical section should include a statement of the world's sugar production and other international statistics for the period being considered, instead of only giving a few figures relating to the home industry. Perhaps, moreover, a list of all the books published in different countries during the period might be added. We have no hesitation in saying that the *Année Sucrière*, will be found by our readers to be invaluable as a work of reference, and we wish it every success.

STAMMER'S TASCHENKALENDER FÜR ZUCKERFABRIKANTEN. Edited by Drs. Frühling and Henseling. 1911-1912. Published by Paul Parey, Berlin, S.W., *10*. Germany. Price, M.4.

Stammer's well-known pocket calendar for sugar manufacturers, which is now in its 35th year of publication, may be recommended as a thoroughly reliable and indispensable authority, which should be in the hands of all engaged in the cane as well as the beet sugar industry. It gives tables and data of daily application in the factory, relating to sugar manufacture, chemistry and physics, engineering and building construction, mathematics, steam and boilers, electrotechnics, agriculture, and statistics. The latter portion of the book, which relates more particularly to the German sugar industry, gives a brief statement by Dr. Claassen of what the German sugar factory manager should know of Government regulations and labour unions, and also deals with commercial regulations respecting the sale of raw sugar and molasses, valuation of beet seed, the patent law of different

countries, and old age and sickness insurance. Lastly, the method of stating the known and unknown losses of the raw beet sugar factory is discussed. The "Taschenkalender" is neatly bound in leather.

ABSTRACTS, SCIENTIFIC AND TECHNICAL.*

ON THE SULPHITATION OF RAW CANE JUICE. *By W. H. Th. Harloof. Archief, 1911, 19, 819-832.*

Whether really on warming limed cane juice before sulphuring any darkening of colour takes place, and if so at which temperature it commences, has been the object of experiments by the author. Raw juices tempered with 1 per cent. (by volume) of milk-of-lime at 15° Bé. were heated to temperatures from 50 to 90° C., and after sulphuring to neutrality, the colour of the clarified juice compared by means of a colorimeter with that of a juice which had been limed and sulphured at the ordinary temperature, *i.e.*, at 30° C. After filtering the defecated and sulphured juices, they were evaporated to one-third of their bulk on the water-bath, and in one series of tests were directly examined for colour, whilst in another the resulting syrups were again sulphured in the usual manner. In making these experiments, the conditions prevailing in practice were imitated as closely as possible, and the following figures were obtained:—

	Lime (CaO) per litre of thin-juice.	Degrees of Colour.		
		Thin-juice.	Thick-juice.	
			Not Sulphured.	After Sulphuring.
Ordinary temperature ..	151	100	241	87
Heated to 50° C..	151	100	250	87
Heated to 70° C..	151	132	260	109
Heated to 90° C..	470	208	484	145

It is therefore shown that darkening sets in between 50 and 70° C., and that the temperature to which the juice is heated has little difference on the lime content, except between 70 and 90° C., when it increases considerably. In a further similar series of experiments, using the same juices, and the same amount of lime, but using temperatures from 30 to 60° C., the following were the figures obtained:—

	Lime (CaO) per litre of thin-juice.	Degrees of Colour.		
		Thin-juice.	Thick-juice.	
			Not Sulphured.	After Sulphuring.
Ordinary temperature ..	140	125	289	64
Heated to 40°C..	145	125	289	78
Heated to 50°C..	123	100	222	71
Heated to 60°C..	134	100	275	67
Ordinary temperature ..	200	203	1000	100
Heated to 40°C..	190	126	760	104
Heated to 50°C..	200	129	640	125
Heated to 60°C..	170	100	670	109

From these series of experiments, the author considers that the conclusion may be safely drawn that heating the limed juice before sulphuring is not injurious, either from the point of view of colour, or from that of ash (lime) content. On the contrary, the figures obtained indicate that on heating a diminution in the colour occurs, and this is seen both in the case of thin and of thick-juices (syrups), although to a less extent in the latter. Further experiments established that 60° C. is the best temperature to which the juice should be heated, as then the colour is lighter, and the lime content lower than at any other. In addition to improvement of colour, it is believed that experiments on the large scale may show that settling and filtration may be carried out more rapidly in the case of treatment at 60° C., and also that the after-products may be more easily worked, on account of decreased viscosity.

PREPARATION OF CARAMEL FOR COLOURING SUGAR. *By J. J. Hazewinkel. Archief, 18, 519-546.*

On account of the irrational custom-house method of valuing raw sugar prevailing in certain countries, a crude kind of caramel is still used in Java for colouring purposes. As at the present time there is much to be desired in the method of preparing such caramel, the author has undertaken to investigate the question of manufacture, more especially from the following points of view:—(1) whether lime should be used; (2) if the caramel should be neutralized; and (3) to what extent the colour of the sugar produced by the caramel diminishes on drying. At the outset of the investigation, certain of the "caramels" now used in Javan factories were analysed with the following results:—

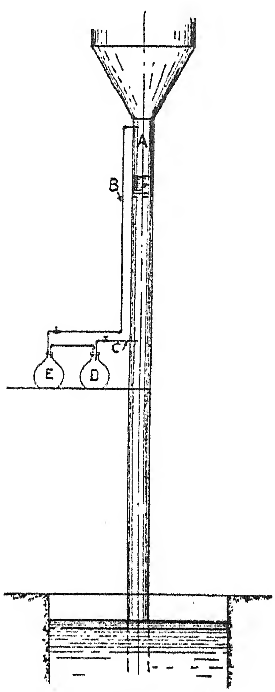
No.	Water.	Clerget value.	Glucose.	Gum.	Ash.	Carbon dioxide in Ash.	Organic Non-sugar.	True purity.
1	50·0	5·8	13·1	3·6	6·2	1·47	22·8	11·6
2	64·0	2·8	6·8	0·6	7·2	2·11	20·7	7·8
3	53·2	13·7	6·6	0·9	8·2	2·57	20·0	29·3
4	30·9	24·3	28·6	1·3	5·0	0·74	10·6	41·1
5	46·5	5·5	21·2	1·2	8·7	2·48	19·4	10·3
6	31·2	14·3	23·3	2·4	8·3	1·78	22·3	20·8

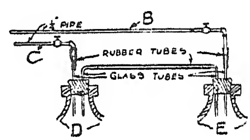
From these analyses, it is seen that, so far as composition is concerned, these caramels may be almost regarded as unchanged molasses, more particularly No. 4, with its comparatively high Clerget value of 24·3, and it was also found that this holds true also for the colouring power. In the experiments, a molasses containing 30·6 per cent. of sucrose and 32·4 per cent. of reducing sugars (glucose) was used; and by heating this with and without lime, to temperatures from 105-170° C., for periods of time from 1 to 6 hours, the following facts were elicited: that if the molasses were heated too long the colour commences to disappear, this decomposition being accompanied by the deposition of carbon; that the maximum colour is produced by heating at a temperature of 125° C. for 5 to 10 hours, the exact time being determined by comparative colorimetric tests made from time to time; that the caramel must be neutralized; that if properly prepared caramel be used there is no diminution of colour on drying; that caramel prepared in the presence of lime is always darker than that made without this reagent, under the same conditions; but that caramel prepared with lime is more difficult to wash off the crystals in the centrifugals. Further laboratory experiments showed that a fully satisfactory caramel for colouring sugars can be made without the addition of lime by heating 100 grms. of the molasses mentioned above with 20 c.c. of water to 125° C. for 5 hours, and finally neutralizing the acid bodies formed. Such a caramel was found to fulfil all the necessary conditions, viz.: (1) a sugar can be sufficiently darkened with it; (2) the coloured sugar can be readily affined when washed with Pellet's liquor; (3) even after drying on the sugar, it remains freely soluble; and (4) it does not make the sugar hygroscopic. This research is still being carried on by the author, who hopes shortly to publish some results bearing more particularly on its technical application.

An Apparatus for the Continuous Sampling of Condenser Water from Evaporators. *By G. P. Meade. Jl. Ind. Eng. Chem., 1911, 3, 507-508.*

Recently R. S. Morris described a method of sampling condenser water (this *Jl.*, 1911, 84-89), in which 5 litres are collected, a litre at a time, at intervals of half-an-hour, as it leaves the condenser, and as near to the condenser as possible. According, however, to the

present author, who is chemist to the Cuban American Sugar Co., although this method of intermittent sampling is the one usually employed, and gives a fairly satisfactory sample when entrainment in multiple effects is being studied, in the case of vacuum pans, in which the quantity and viscosity of the contents are constantly changing, such a sample may fail to be representative. In order to obviate this source of error, he has devised an apparatus (see the following sketches) by means of which a sample may be taken continuously throughout a convenient period of time. It is stated to have been used successfully for two years. *A* is the leg-pipe of the condenser of the evaporator. *B* is a quarter-inch pipe entering the leg-pipe near the top. *C* is a second quarter-inch pipe entering at any convenient point below the lowest level at which the water column in the leg-pipe will stand when the evaporator is in use. These quarter-inch pipes project into the leg-pipe about two inches. This prevents rust and dirt from the sides of the condenser from washing into the sample. *D* and *E* are heavy glass carboys. They are connected as shown in



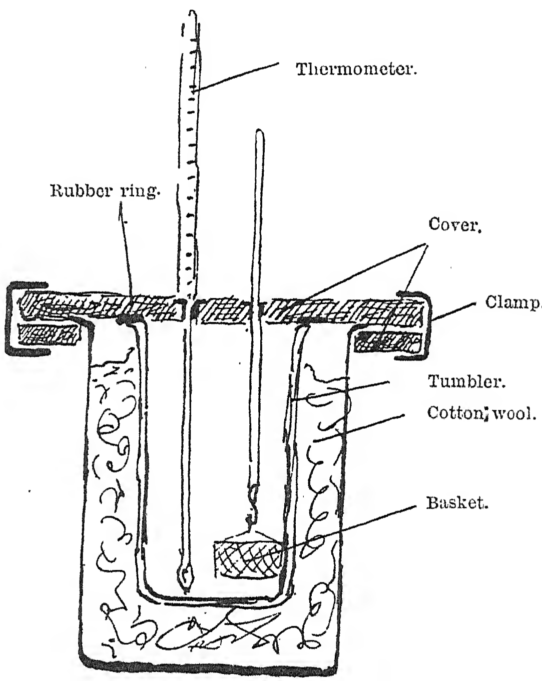


the small drawing. All connections must be air-tight. When the valves on *B* and *C* are opened, the sampling apparatus becomes a part of the vacuum system. The condenser water is forced through *C* into the carboy *D* by the pressure of the column of water in the leg-pipe above *C*. By manipulating the valves the water may be made to flow into *D* in a full stream, or drop by drop as desired. *E* serves as a trap to catch any water from the upper pipe when the vacuum is broken. The sample will stop running when the vacuum is broken, but it will start again when the vacuum is sufficient to lift the column of water in the leg-pipe above the level of *C*. Preparatory to taking a sample, the rubber connection between *C* and *D* should be broken and the end of *C* immersed in a little clean water. The valve is then opened. The water will be drawn through the pipe and will

clear it of rust and dirty water. It is stated that the carboys used must be carefully selected, as there is danger of a serious accident if they are not sufficiently heavy to withstand the atmospheric pressure. As a precaution it is recommended that they should always be covered with bagging when in connection with the vacuum system.

ON THE CONTROL OF THE LIME KILN. *By Ed. Koppeschaar. Tijdschrift der Algemeene Technische van Beetwortelsuikerfabrikanten en Raffinadeurs, 1911, 2, 25-30.*

Although the modern lime kilns installed in beet factories, or in cane factories working the carbonatation process, give excellent results, the production of a lime containing the minimum amount of



either "unburnt" or "deadburnt" product requires careful regulation. In addition to the empyrical method of observing the course of the operation through the sight-holes, the chemist may use the following means of effecting a more regular control: (1) by periodically analysing the gases; (2) by determining the temperature in the dissociation zone; (3) by ascertaining the amount of vitreous lime returned from the slaking station; and (4) by calorimetric deter-

minations of the heat evolved on slaking. In reference to the last-mentioned method, the author describes his favourable experience of the Hoogvliet apparatus, which is stated to have rendered good service throughout the last five campaigns in the Vierverlaten factory in Holland. This apparatus is simply a calorimeter, in which the amount of heat evolved on slaking a sample of lime can be rapidly determined, and thus an indication of the quality of the material, as regards "hardness," obtained. In using the calorimeter, the construction of which is quite apparent from the figure on previous page, 10 grms. of the sample are slaked in 100 c.c. of water contained in the tumbler, and both time and temperature noted, after which by a simple calculation the percentage of CaO may be found, and thus a figure obtained affording a conclusion as to how the lime has been burnt. Theoretically from 10 grms. of CaO 2·5536 calories are liberated, and if the weight of the glass be 75 grms., the temperature will rise :

$$\frac{2 \cdot 5536}{75 \times 0 \cdot 777 + 100 - 3 \cdot 34 + 13 \cdot 34 \times 0 \cdot 2} = 22 \cdot 7^\circ \text{ C.},$$

in which 0·777 is the specific heat of glass; 3·34, the water in grms. with which 10 grms. of CaO combine; 13·34 the $Ca(OH)_2$ (calcium hydrate) formed; and 0·2 the specific heat of $Ca(OH)_2$. This rise of temperature being known for 100 per cent. CaO, in order to determine the CaO content of any sample of lime under examination, it is only necessary to find its rise of temperature, and make a simple rule-of-three calculation. As illustrating the reliability, as well as the rapidity, of the method, the author gives the following examples :—

Sample of Lime.	CaO per cent.		Time taken.	
	Calorimetrically.	Volumetrically.*	Calorimetrically.	Volumetrically.*
A	91·5	91·2	2 minutes.	3½ hours.
B	94·8	95·9	3 ,,	,,
C†	34·7	—	32 ,,	—
D†	63·2	—	64 ,,	—

It is finally pointed out that by making the apparatus larger, say of a capacity of half a kilogram, it would be more convenient for manipulation by the foreman, and in this form would be of much use in controlling the working of the kilns.

SAMPLING FILTER PRESS CAKE. *By J. Lubtschenko. Zapiski, 12, 677;* through *Centr. Zuckerind., 1911, 19, 1383-1384.*

In order to obtain an insight into the degree of accuracy of different methods of sampling the author has carried out four experiments,

* By solution in sugar liquor, and titration with standard acid.
† Both C and D were "dead burnt."

using an Abraham filter press, and determining the sugar in the cakes by the ammonium nitrate process. In the first experiment

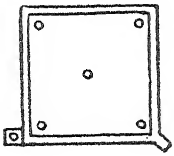


Fig. 1.

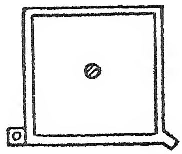


Fig. 2.

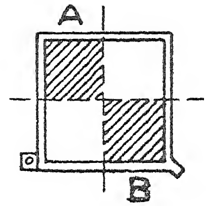


Fig. 3.

samples were taken from 17 frames of the press by means of a Hermann probe in the manner indicated in *Fig. 1*, with the following results for the sucrose content:—

1	1·60	6	3·90	10	0·30	14	2·70
2	1·80	7	1·60	11	2·80	15	0·60
3	0·30	8	2·90	12	4·00	16	1·30
4	0·40	9	0·40	13	2·50	17	3·40
5	2·10						

giving an average of 1·91 per cent. of sugar. In the second experiment the samples were taken from 36 frames of the press in the way shown in *Fig. 2*, and the following sucrose figures obtained:—

1	0·30	10	1·90	19	2·40	28	0·20
2	0·60	11	2·00	20	0·10	29	0·20
3	0·70	12	0·60	21	0·50	30	0·20
4	1·40	13	0·80	22	0·80	31	0·10
5	1·00	14	3·50	23	1·30	32	3·50
6	1·30	15	1·00	24	0·50	33	0·80
7	0·50	16	2·90	25	0·50	34	0·90
8	0·60	17	1·90	26	0·60	35	1·40
9	1·10	18	1·70	27	0·20	36	1·70

with an average of 1·30 per cent. of sugar. In the third experiment the samples were taken here and there, irregularly, from different parts of the cake, when the sucrose content was found to vary as follows:—

1	0·80	10	7·50	19	0·40	28	0·80
2	0·60	11	10·80	20	0·70	29	0·30
3	0·80	12	0·80	21	0·30	30	0·70
4	0·50	13	1·90	22	3·20	31	0·40
5	0·50	14	1·90	23	4·00	32	1·00
6	0·80	15	0·50	24	1·50	33	0·50
7	0·80	16	0·50	25	0·50	34	0·40
8	0·60	17	0·50	26	1·60	35	0·70
9	1·20	18	0·30	27	0·40	36	1·60

which figures average 1·08 per cent. of sugar. In the fourth and last experiment the cake was sampled from two parts, A and B, as

shown in *Fig. 4*, and each part analysed separately, with the following results for the sucrose:—

	A.	B.		A.	B.
1	1·40	0·40	8	0·60	3·50
2	0·40	5·50	10	0·50	5·60
4	3·80	0·30	12	0·40	0·90
6	6·00	0·40	14	3·20	4·30

giving an average for A of 2·04, and for B of 2·98 per cent. of sucrose. From these four experiments it is clear that the sugar in filter press cake varies, according to the number of the frame of the press, and also according to the part of the cake taken as the sample. In some cases the differences are very considerable, depending upon the quality of the cake, and upon the regularity of the porosity of the filter cloths.

On a Uniform Method of Determining the Dry Substance in All the Products of the Sugar Factory. *By Th. Koydl. Zeitsch. Zuckerind. Böhm., 1911, 35, 491-497.*

As the considerable amount of literature that has been published within recent years has shown, the question of an accurate method of ascertaining the dry substance of sugars, molasses, syrups, and juices, so as to estimate the so-called "true" quotient of purity, is far from being settled. One of the best known investigators in this field is the present author, who has shown that the customary methods do not give the correct relationship between the amount of dry substance in raw sugars on the one hand, and syrups on the other. This is perhaps only what might be expected, since the conditions under which the two products are examined are not at all the same, the raw sugar being simply dried for a short time, whereas the syrup is mixed with sand and alcohol, and heated for a considerably longer period. In this article Koydl now advocates, so as to obtain more comparable results, carrying out the determination of the dry substance in these two classes of products under more similar conditions. It is pointed out that in so doing two courses may be adopted: either (1) the raw sugar may be dissolved to a syrup, and this dried in the usual way adopted for syrups; or (2) the syrup may be mixed with sugar crystals in the proportion of 1 : 9, thus making an artificial raw sugar, which is dried according to the method generally prescribed for raw sugars. Since, however, the first procedure would be unnecessarily tedious, it is now advocated that the second should be adopted as the uniform method. It is argued that for a standard method the use of sand should be left out of consideration, since in raw sugars and massecuites sugar crystals are already present, and the results obtained with sand as the distributing agent do not agree with those found when sugar is used. Sugar, therefore, it is held, should be used for all products; raw sugar requires no further addition of sugar

crystals; massecuite very little; syrup a proportional amount according to its density; while very thin syrup and thin-juice should be previously evaporated *in vacuo* at a low temperature before adding the suitable amount of sugar crystals. As, moreover, it is considered that the fineness of the distributing agent exerts an influence, it is recommended that the size of the grain used should correspond to that of raw sugar, as follows, the figures denoting the length of the axis of the crystal: 1 part of 2·0 to 1·3 mm.; 1 part of 1·3 to 0·65 mm.; and 1 part of 0·65 mm. to the finest crystal powder.

Other articles of interest to sugar technologists, but unsuitable for abstracting, are:—

Bagasse Furnace Design (Parts II, III, IV, and V.) *By E. W. Kerr. Modern S. Planter, 1911, 41, No. 30, 2-5; No. 33, 2-5; No. 40, 2-5;* and *No. 42, 2-4.* Illustrated.

Evaporators and Vacuum Pans. *By B. Viola. Metallurgical and Chemical Engineering, 1911, 9, 206, 250, 306,* and *356.* Illustrated.

An Automatic Coal Weighing Machine, and a Feed Water Meter for Sugar Factories. *By H. Souček. Zeitsch. Zuckerind. Böhm., 1911, 35, 292-300.* Illustrated.

Machines for Forming and Pressing Sugar. *By W. Daude. Zeitsch. Ver. deut. Zuckerind., 1911, 25-51.* Illustrated.

An Hydraulic Buffer Appliance for Cane Mills. *By J. J. Steensma. Archief, 1911, 19, 932-935.*

Hydraulic Pressure in Mill Work. *By J. F. Gogelein. Aflevering 1. By B. B. Lugten. Aflevering 2. Handelingen van het negende Congres (1911), Soerabaia, Java.*

The Selection of the Sugar Cane, and its Practical Signification. *By A. Nash. Aflevering C. By J. E. Van der Stok. Aflevering B. Handelingen van der negende Congres (1911), Soerabaia, Java.*

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E. Chartered Patent Agent, 6, Lord Street, Liverpool; 77, Market Street, Bradford; and 285, High Holborn, London.

ENGLISH.—Application.

15523. E. Weber and G. Räther. *Presses for making cubes of sugar and other articles.* (Convention date, July 4th, 1910, Austria.) (Complete specification.) 4th July, 1911.

ENGLISH.—Abridgment.

19719/10. J. J. Homans, Samarang, County Samarang, Java. *Improvements in separating scum and precipitates from sugar juice and solutions.* Date of application, 23rd August, 1910. This invention has for its object the process of separation of sugar juice, and impurities according to their respective specific gravities, characterized by this that the sugar juice is subjected to centrifugal action, while maintaining its temperature, during the entire treatment, at not less than 94°C. or 95°C. (the "cracking" point of the defecation process).

GERMAN.—Abridgments.

234421. Harburger Stärkefabrik Friedrich Thorl, of Harburg on Elbe. *A process for making starch in a finely radiated form.* (Patent of Addition to Patent No. 205763, of 9th March, 1907.) 23rd of June, 1909. In this process which is an improvement on that described in the principal Patent for making starch in pieces or rays, the tablets or blocks are first treated with dry hot air and then with moist hot air in order to obtain a finely radiated article.

234725. Dr. Emil Preissler, of Ricklingen. *A process for separating sugar beets from foreign matters of lighter volumetric gravity, such as beetroot leaves, couch grass, fibrous substances, &c.* 20th July, 1910. The mixture of sugar beet and foreign matters is delivered on to a rough surface roller, which rotates in a direction opposite to that in which the beetroot is travelling and the axle bearings of which are adjustable, at such an angle and such a speed that the energy of movement of the roots overcomes the frictional resistance of the roller moving in the opposite direction and the roots fall off the roller on the outer side *i.e.*, on its upwardly moving side, whilst the bodies of lighter volumetric gravity are carried by the roller to the opposite side and thrown off there.

235129. Firm Oscar Bondy, of Vienna. *Sugar loaf press.* (Patent of Addition to Patent No. 159413, of 26th April, 1904.) 31st August, 1910. This is a press of the kind described in Patent No. 201412, a Patent of Addition to Patent No. 159413, and is characterized by one half of the press mould being adapted to be turned out of its normal position about an axis lying at the point of the sugar loaf chamber or not far from this point, in order to enable the mould to be enlarged when being filled, so that sugar loaves of uniform density are obtained in consequence of more of the material to be compressed being contained in the mould towards its base.

235511. Niklaus Richter and August Schnettler, of Hagen, Westphalia. *A beetroot shredding machine knife box with an adjustable*

front bar and an adjustable knife bar. 1st May, 1910. The adjustment of the front plate or bar which is provided with separate slide pieces and of the knife bar is done by means of set screws, resilient abutments being provided in the form of springs fitting in grooves at the ends.

235700. Dr. OTTO EMMRICH, of Schöneberg-Berlin. *Process for heating and mashing fresh beetroot shreddings in a continous operation.* 28th May, 1908. In this process the juice and water under pressure serving for heating the shreddings are forced at right angles to the stream of shreddings introduced in successive fields into a tapering diffuser for the purpose of forming a plug or clot of shreddings under repeated heating until a temperature which is favourable for hot continuous diffusion is attained.

235617. SOCIÉTÉ ANONYME DE LA RAFFINERIE A. SOMMIER, of Paris. *A machine for cutting and packing sugar.* 27th October, 1909. This comprises a feed device, a cutting device and a packing device, the latter consisting of a table on which the pieces of sugar coming from the cutting mechanism are placed in succession and a tongs or gripper which takes up successively the pieces of sugar, which vary in number, and packs them in a holder, the movement of the tongs being controlled by a counting disc which is moved by the cutting device in such a way that it is advanced one division after each cut, and pins are provided on it at given intervals, each of which successively once sets in motion the packing device after the cutting device has made a given number of cuts or after a given number of pieces of sugar have been piled up on the table, whereby it is possible to pack rows of different lengths.

UNITED KINGDOM.

IMPORTS AND EXPORTS OF SUGAR
To End of July, 1910 and 1911.

IMPORTS.

Unrefined Sugars.	1910. Tons.*	1911. Tons.*	1910. £	1911. £
Russia	93	1,061	1,190	11,451
Germany	94,396	335,777	1,273,504	3,491,649
Netherlands	7,467	3,485	89,695	32,677
Belgium	3,003	7,305	37,139	76,508
France	431	47	6,260	425
Austria-Hungary	40,101	40,057	535,204	404,326
Java	5,162	5,767	76,785	73,035
Philippine Islands	....	....	....	....
Cuba	96,290	3,868	1,370,993	29,610
Dutch Guiana	3,704	4,246	53,919	51,108
Hayti and San Domingo	67,016	25,990	944,051	279,412
Mexico	10,107	6,646	143,846	77,507
Peru	36,883	18,535	492,575	175,332
Brazil	47,132	7,464	569,586	63,194
Mauritius	35,677	26,336	524,717	230,549
British India	7,259	1,751	77,108	14,389
Straits Settlements	792	174	9,389	1,700
Br. West Indian Islands, Br. Guiana & Br. Honduras	62,424	45,998	922,742	613,896
Other Countries	17,563	10,305	233,539	97,258
Total Raw Sugars	535,500	544,812	7,362,242	5,724,026
Refined Sugars.				
Russia	94	42,741	1,452	536,331
Germany	211,308	259,042	3,342,677	3,405,346
Holland	50,918	74,719	841,825	1,032,664
Belgium	15,974	24,159	276,684	339,862
France	55,511	3,585	919,336	52,383
Austria-Hungary	121,155	132,582	1,987,340	1,767,785
Other Countries	51,960	1,558	899,964	19,953
Total Refined Sugars	506,920	538,386	8,269,278	7,154,324
Molasses	94,216	75,701	432,472	307,883
Total Imports	1,136,636	1,158,899	16,063,992	13,186,233

EXPORTS.

British Refined Sugars.	Tons.	Tons.	£	£
Denmark	2,342	2,994	33,982	35,622
Netherlands	1,823	1,784	28,175	23,920
Portugal, Azores, & Madeira	817	703	11,954	8,092
Italy	155	920	2,176	10,833
Canada	4,585	5,206	73,559	76,071
Other Countries	4,569	6,819	85,228	105,178
	14,291	18,426	235,074	259,716
Foreign & Colonial Sugars				
Refined and Candy	428	807	8,165	11,728
Unrefined	2,794	4,645	40,279	54,596
Various Mixed in Bond	75	....	1,285	....
Molasses	205	261	1,572	1,698
Total Exports	17,793	24,139	286,375	317,738

* Calculated to the nearest ton.

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1911. Tons.		1910. Tons.
Total Receipts January 1st to July 27th	1,474,085	..	1,592,384
Receipts of Refined ,, ,, ...	231	..	149
Deliveries ,, ,, ...	1,421,214	..	1,592,384
Importers' Stocks, July 26th	52,871	..	68,303
Total Stocks, August 2nd	219,000	..	366,200
Stocks in Cuba, ,, ...	91,000	..	166,000
	1910.		1909.
Total Consumption for twelve months ..	3,350,355	..	3,257,660

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR FOR 1909, 1910 AND 1911.

(Tons of 2,240 lbs.)	1909. Tons.	1910. Tons.	1911. Tons.
Exports	1,142,638	..1,355,965 ..	1,123,816
Stocks	223,552	.. 300,558 ..	251,822
	1,366,190	.. 1,656,523 ..	1,375,638
Local Consumption (6 months)..	31,780	.. 33,152 ..	36,850
	1,397,970	.. 1,689,675 ..	1,412,488
Stock on 1st January (old crop)..	....	.. ..	....
Receipts at Ports up to June 30th	1,397,970	1,689,675	1,412,488

Havana, 30th June, 1911. J. GUMA.—F. MEJER.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION OF SUGAR FOR SEVEN MONTHS ENDING JULY 31ST, 1909, 1910, 1911.

	IMPORTS.			EXPORTS (Foreign).		
	1909. Tons.	1910. Tons.	1911. Tons.	1909. Tons.	1910. Tons.	1911. Tons.
Refined	585,074	.. 506,920	.. 538,386	469	.. 428	.. 807
Raw	458,403	.. 535,502	.. 544,812	2,267	.. 2,869	.. 4,645
Molasses	98,105	.. 94,216	.. 75,701	173	.. 205	.. 261
	1,141,582	1,136,638	1,158,899	2,909	3,502	5,713

	HOME CONSUMPTION.		
	1909. Tons.	1910. Tons.	1911. Tons.
Refined	576,679	.. 481,500	.. 536,327
Refined (in Bond) in the United Kingdom........	347,309	.. 362,555	. 391,683
Raw	71,293	.. 82,553	.. 73,433
Molasses	80,744	.. 86,338	.. 77,218
Molasses, manufactured (in Bond) in U.K........	41,748	.. 40,198	.. 45,616
Total........................	1,117,773	..1,053,144	..1,124,277
Less Exports of British Refined.................	18,149	.. 14,291	.. 18,426
	1,099,624	1,038,853	1,105,851

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, JULY 1ST TO 31ST, COMPARED WITH PREVIOUS YEARS.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1911.
139,400	669,310	226,720	303,510	132,980	1,465,920

	1910.	1909.	1908.	1907.
Totals ..	..1,360,410	..1,532,130	..1,550,560	..1,705,880.

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING JUNE 30TH, IN THOUSANDS OF TONS.

(Licht's Circular.)

Great Britain.	Germany.	France.	Austria-Hungary	Holland, Belgium, &c.	Total 1910-11.	Total 1909-10.	Total 1908-09.
1897	1340	758	649	240	4885	4754	4631

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1910-1911.	1909-1910.	1908-1909.	1907-1908.
	Tons.	Tons.	Tons.	Tons.
Germany	2,602,000	..2,033,834	..2,082,848	..2,129,597
Austria	1,535,000	..1,256,751	..1,398,588	..1,424,657
France	725,000	.. 806,405	.. 807,059	.. 727,712
Russia	2,140,000	..1,126,853	..1,257,387	..1,410,000
Belgium	285,000	.. 249,612	.. 258,339	.. 232,352
Holland	223,000	.. 198,456	.. 214,344	.. 175,184
Other Countries .	590,000	.. 465,000	.. 525,300	.. 462,772
	8,100,000	6,136,911	6,543,865	6,562,274

THE

INTERNATIONAL

SUGAR JOURNAL.

No. 153. SEPTEMBER, 1911. Vol. XIII.

☞ All communications to be addressed to the Editor, Office of "The Sugar Cane," Altrincham, near Manchester. All Advertisements to be sent direct.

☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

Cheques and Postal Orders to be made payable to NORMAN RODGER, Altrincham.

The Editor will be glad to consider any MSS. sent to him for insertion in this Journal and will endeavour to return the same if unsuitable; but he cannot undertake to be responsible for them unless a stamped addressed envelope is enclosed.

NOTES AND COMMENTS.

The Sugar Market.

The sustained drought on the Continent has had very far-reaching results on the sugar supplies, and the promised deficiency of sugar runs into seven figures. According to Czarnikow, one million tons' shortage is currently talked of as a minimum, and some say this figure will apply to Germany alone. The fields abroad look deplorable. The leaves are only about one-third of last year's weight, and as the roots will now make little progress, the deficiency will go on increasing. In cane-producing countries, there is a drought in Cuba to record, while in Formosa a hurricane is supposed to have destroyed 10 per cent. of the crop. In Natal lack of rain has considerably reduced the output, while in Mauritius the yield of canes per acre is below anticipations. At home the price of 88 per cent. beet has gone up to practically 18s., a figure only once exceeded for one short period since 1889, and it may be expected to rise further still. The Russian supply remains the dark horse; it is uncertain what quantity she will have available for export over and above the contingent; but in a year's time it may possibly equal the present shortage. The visible supplies on September 2nd were 1,402,730 tons as compared with 1,539,880 tons last year, the proportion in the United Kingdom being 161,300 tons.

Economic Aspects of a British Beet Sugar Industry.

Under the title of "Economic Aspects of the Introduction and Establishment of a British Beet Sugar Industry" Mr. Sigmund Stein, of Liverpool, read one of his characteristic papers at the annual meeting of the British Association, held at the commencement of this month at Portsmouth. Unfortunately for Mr. Stein the subject did not prove a "draw" and the attendance was extremely meagre; but several of the leading newspapers devoted considerable space to his paper, so that he will have little cause to complain. He began by referring to the pre-eminent position the United Kingdom holds as a consumer of sugar. The annual consumption is in fact 91½ lbs. per head and last year 1,745,129 tons of sugar (only 441,810 tons of which, by the way, was cane) were imported. Apart from the United States which accounts for 81 lbs. per head, and Denmark with 70 lbs., there is hardly a country that approaches within 60 per cent of our figures. This superiority being postulated, the question arises as to whether it would not be of economical benefit to the nation to produce this article of diet herself. Mr. Stein's paper is full of arguments and figures to convince one that it would, and while there are times when we are inclined with reason to discount his optimism, it must be admitted that here he consolidates the strong case that has been made out in favour of the home production, even though some of his figures might be questioned and some of his deductions might hardly bear close investigation. Mr. Stein next proceeds to point out how agricultural interests have declined in England during the last 50 years, the income from land and the area of arable land as against *pasture* having dropped considerably; he then turns to review Continental practice and shows how not only has sugar beet growing there benefited agriculturists *per se* but it has resulted in an improvement in other branches of agriculture, the yields of cereals having greatly increased since the cultivation of beetroot introduced more scientific tillage of the soil. There has also been an indirect benefit to live stock, owing to the abundance of by-products and residues which can be employed as cattle food. This benefit is lacking in England; and when we are shown by Mr. Stein that since 1891 our supplies of farm stock have suffered a decrease, we may assume that, even if this is not *cause and effect*, at any rate a larger and cheaper supply of feeding material might be expected to encourage the production of a larger number of animals. Another point dwelt on by the lecturer was the relative proportion between agriculture and industry in this country; 59 per cent. of our population are engaged in industrial work and only 8½ per cent. in agriculture, whereas in Germany, for example, the figures are respectively 37 and 38 per cent. But this question, though it ought to be a national one, has by now, we fear, become too much of a political one. At any rate the disciples of Cobden who are at

present in power are too bent on leaving what they fondly imagine is *free* trade to run its course unchecked rather than take any radical steps to resuscitate a decaying industry; while the tariff reformers are pledged to take some such steps not only for the agriculturist but also for the industrialist—only the purveyor of foreign goods and foreign agriculture would be left out in the cold. Meanwhile the nation listens with apparent indifference to the warnings that are given from time to time with reference to our food supply. That we obtain 75 per cent of our food from foreign countries does not trouble us at all and doubtless will not till war stares us in the face. Yet if an abnormal spell of weather can upset our supplies of sugar as is happening just now, and send the price up to the highest figure we have had since 1893, it is not difficult to realize what effect a European upheaval would have, not only on our sugar but also our corn supplies. But your modern British economist thinks only of To-day, and trusts that somehow or other To-morrow will not be rainy, as he has not provided for it.

The Sugar Machinery Market.

A correspondent of *The Times* reports that there is at present in the Glasgow district a good demand for sugar machinery. "Several firms who have been very busy for more than twelve months have booked substantial new orders, principally for South America and the East. The Continent of Europe sends very few contracts of this kind to Glasgow, as each country is able to supply most of its own requirements. Not only so, but British makers obtain from the Continent, at lower rates than they would have to pay at home, certain sections of steel material for the construction of sugar machinery which they export elsewhere. There are hopes of further new work from Java, Brazil, and Argentina, and also from Australia, after the possibilities of that island continent for sugar-raising purposes are fully realized."

Cuba, also, has been in the market for new plant, and we learn that Messrs. A. F. Craig & Co., Ltd., of Paisley, have secured from a Cuban Company the order for a complete new crushing plant and accessories, comprising four 3-roller mills, 36 in. × 78 in., with Krajewski crusher, driven by two Corliss engines, 46 in. × 60 in. and 26 in. × 60 in. respectively; as well as a cane unloader of the "Goliath Crane" type with elevator and carriers, &c. This firm have also on hand a considerable amount of smaller work for the sugar industry; and they have recently had to increase the capacity of their works by the addition of a large new erecting shop, 64 ft. span by 186 ft. long.

A Unique Factory.

While on the subject of sugar machinery, it is interesting to record the success of an experiment tried in Porto Rico some four years ago

in the combining of a scratch lot of old British machinery to form a new mill. Mr. D. L. Thomson, who was then, and still is, consulting engineer for the Central Eureka, fitted up that usine with old English machinery collected from all over the island, and combined it to make a new factory. He of course at the same time purchased a new milling plant as the old one was not considered strong enough for modern requirements though undoubtedly of the finest material and workmanship. This central with its scratch collection of apparatus has, we learn, been an unqualified success from the start, and many efforts have been made to buy it from the owners, who recently refused an offer of $500,000 for the factory and appurtenances alone.

Porto Rico.

We hear that crop prospects are particularly good in Porto Rico this year, the weather so far having been all that could be desired, and if the usual rains fall in November, the 1912 crop should be a record one. Porto Rico is now so well supplied with centrals that it is exceedingly difficult to get a suitable site for a new one without interfering with those already established, and the latest propositions are mostly for smaller factories in the interior, where transportation of sugar to the coast makes them less attractive. The last big central to be erected was *Vannina*, the contract for which was secured by the Krajewski-Pesant Co. It is capable of grinding 750 tons of cane a day, and it recently finished a crop of 42,000 bags of sugar with a recovery of 12 per cent. sugar on weight of cane.

Beet-Growing in Norfolk.

The British Sugar Beet Council states that the crops of sugar beet being grown in Norfolk under contract promise to turn out extraordinarily well. Last year much adverse criticism was based upon erroneous ideas of the results of the crops grown, in consequence of the comparatively low weights paid for by the Holland factory to which the roots were exported. It was afterwards explained that the seed having been sown many weeks too late on unprepared land by farmers unacquainted with the proper methods of cultivation, together with the factory custom of doubling the deduction for dirt adhering to the roots when it exceeded 20 per cent., sufficiently accounted for any dissatisfaction on the part of the growers.

This year the contracts, which are on a considerable scale, have provided for the cultivation to be conducted according to the instructions and under the supervision of Continental experts, who are surprised at the gratifying results. It is now some four weeks to the time when they will be taken up, but many of the roots already weigh over 2 lb., and as sunshine generally conduces to high percentage of sugar, the amount of sugar produced per acre of beets may, in spite of the exceptional drought, be above the average.

International Congress of Applied Chemistry, 1912.

A second and more detailed announcement relating to the eighth International Congress of Applied Chemistry, to be held in Washington next September, has recently been issued. From this we gather that the Sugar Section will embrace eleven topics, viz., 1, Raw Cane Sugar Manufacture; 2, Raw Beet Sugar Manufacture; 3, Maple Sugar Manufacture; 4, Sorghum Sugar and Syrup; 5, Milk Sugar Manufacture; 6, Sugar Refining; 7, Candy; 8, Preserves; 9, Condensed Milk; 10, Beet Seed Farming; and 11, Honey and Adulterants. It will be seen that a very comprehensive list has been prepared and it only remains to hope that ample support will be forthcoming in the shape of useful and interesting communications.

THE FUTURE OF THE BEETROOT INDUSTRY.

The history of the sugar production of the world since the middle of the last century is full of interest and instruction. Cane sugar was then supreme. The British consumer was entirely supplied with refined sugar by the British sugar refiner; and that portion which he consumed in the form of raw sugar he obtained from our West Indian Colonies and the neighbouring islands of Porto Rico and Cuba. The British sugar refiner's raw material came also principally from our West Indian Colonies and our Colony of Mauritius; the foreign sugar producing districts of Cuba, Porto Rico, Brazil, the Philippine Islands and Java completed the supply. In times of scarcity and high prices we occasionally received shipments from British India and even China.

By the end of the century everything was changed. A complete revolution had taken place in the sugar production of the world. Beetroot sugar had taken the place of cane sugar to the extent, at one time, of nearly two-thirds of the total. The British consumer received annually nearly a million tons of his refined sugar from foreign countries. The British refiner used European beetroot instead of tropical cane sugar as his raw material. Our sugar producing Colonies had to seek elsewhere for markets for their production.

This marvellous supplanting of cane by beet sugar was greatly stimulated by the bounties obtained by the beetroot sugar producers from their more or less paternal Governments. At last, after thirty years of negotiations, these bounties were finally abolished in the year 1903. Again the history of the world's sugar production becomes an interesting study. Two questions are now before us for solution. How will the European beetroot industry get on without its bounties? How will the cane sugar production of the world behave now that it once more enjoys freedom of competition? These are the interesting problems of the future. They are, of course, not simple problems. Economic questions are always complicated by cross currents of other

minor influences. Cane and beet have not yet had the arena sufficiently clear of all disturbing incidents to enable them to fight out the battle which must end some day either in the survival of the fittest or the equality of the combatants.

As to the first question, it may be replied that the beetroot industry has faced its new position bravely and with success. It is true that big factories have pushed the small ones out of the competition. It is also true that the French production has fallen off. But there are special causes for this, in addition to the main one of a certain amount of inferiority both in agriculture and manufacture. The French factories have had to compete for their supply of roots against the flourishing distilleries. On the other hand, Holland and Belgium have progressed, Germany still holds the lead, Austria—and especially Hungary—increases its output, and lastly, Russia, where bounties still flourish, is going forward by leaps and bounds towards the winning post.

This maintenance of their position by the beetroot producers shows that an industry when firmly established, no matter how artificially, can for a time stand its ground even when its props are finally removed. One reason why France is weaker than the others is that her artificial stimulus was applied at a later date, so that she never reached the perfection of growth and manufacture attained by Germany and Austria. This is a most important lesson to be learned from our sugar history and entirely upsets the favourite doctrine that "protection" gives rise to apathy and want of enterprise. The French beetroot sugar industry suffered severely from these diseases up to the time when the French Government saw that if the industry was to be saved they must adopt the German system of bounties. From that moment the French industry rapidly progressed. Rich roots were grown instead of poor ones, and the diffusion process of extraction of the juice was substituted for the old-fashioned presses, long since discarded in all the competing countries. But France had not time, before the abolition of the bounties, to catch up with Germany in the industrial race. Moreover, Germany had made such good profits that the manufacturers were enabled continually to write off from their capital account. Hence they can now work their factories at a lower cost of production than that incurred by most of their competitors.

The European beetroot sugar industry, therefore, has gone on contributing some seven million out of the fourteen million tons of our total visible supplies. The Indian crop we do not yet include among our visible supplies because its estimate of production is a very vague figure. But India is now a large importer of sugar and has become a very considerable element in the world's consumption of visible supplies. Last year the European beetroot production jumped up to eight million tons, against about six milllion tons of visible cane sugar supplies. All the beetroot crops, except in France, were

remarkably good and the acreage sown was a maximum owing to the good prices after the short crop of the year before. The European beetroot production attained its enormous dimensions partly by means of the stimulus of the bounties. At present it still maintains the lead. It is still the main governing cause of rise and fall in the price of sugar, and that we must still attribute to the artificial effect of the bounty stimulus in having created such a predominating factor in the world's sugar markets. In 1900, 1901, and 1902 we had a plethora of beetroot sugar and prices went down three shillings per cwt. below the cost of production. In 1904 the drought in Europe caused the production of beetroot sugar to come out 1,200,000 tons below the estimate, and prices went up a hundred per cent. This year the same calamity is upon us, and again we have a rise in price of similar violence. These serious disturbances in the world's sugar markets are entirely owing to our dependence for more than half our sugar supplies upon the weather in a small portion of the Continent of Europe. It was the bounties that created that dependence and, therefore, we have to thank them for the present high price of sugar.

When will this abnormal disturbance cease? The production of cane sugar is increasing rapidly, and the time is not far distant when cane and beet will have to fight it out on equal terms as to which is to be the predominant factor in the world's supplies. The beetroot industry is quite alive to this serious outlook for its future and is getting ready for the struggle. Dr. Bartens, Editor of *Die Deutsche Zuckerindustrie*, dealt rather fully with the subject at the recent general assembly of the Association of the German Sugar Industry. He very correctly drew the distinction between the progress of this industry as compared with that of cane sugar, that while cane sugar progressed continuously the progress of the beet industry was rather "up and down." There had been four rises and falls in the production of beetroot sugar during the last ten years. When low prices came the production of cane sugar was less influenced than that of beet because the cost of production was lower. Also the production of cane sugar was more "decentralized," and, therefore, less subject to weather variations because not concentrated in one particular district. Fortunately for the beetroot industry, which last year had such a record crop, new outlets for the surplus had been found, and good exports had enabled them to escape the danger of heavy stocks. Russia was a menace for the future owing to its constantly increasing production. It did not yet produce quite so much sugar as Germany, because the agricultural yield was very poor, but it now cultivated 785,000 hectares as compared with 500,000 in Germany. If the increase continued it would be necessary to stimulate the home consumption. It is true that part of the Government regulation of the industry is that the maximum fixed price for home consumption is automatically reduced every year; but a reduction of only about 3d.

per cwt. is not of much account. The Austrian Cartel is another danger, but at present it does not appear to have resulted in any great increase in exports. The French production has so much decreased that France has now very little export trade. Germany maintains its position as the largest producer. Fifty of the smaller factories have disappeared since 1903, but concentration of work in the larger factories has helped to reduce the cost of production. Therefore the Brussels Convention has not reduced production except in the case of France. The Convention has undoubtedly had a good effect in securing for all producers equality of opportunity, until the British Government, in 1907, upset the arrangement by refusing to adhere to the penal clause. The effect of this is, that there is now no hope of inducing other countries to renounce bounties. So far, therefore, the Convention has collapsed. The Permanent Commission has also, Dr. Bartens thinks, become rather slack in not dealing with the question of *admission temporaire* in France, and with the peculiar position of Cuba. But he admits that the artificial stimulus to increased production in Cuba—the preferential duty accorded to Cuba by the United States—is "with difficulty to be included in a system of bounties as defined by the Brussels Convention." The great advantage still remaining in the Convention is, in Dr. Bartens' opinion, the compulsory reduction of the surtax, which means reduced danger from Cartels. It is, he thinks, a question whether, if the Covention were abolished, the industries would be opposed to an increase in the surtaxes. The present defects in the mutilated Convention are, therefore, to be endured rather than abandon the compulsion with regard to the surtax. In any case he hopes that when the time comes for a decision it will be "of such a nature as to guarantee for the future the existence and continued life of the German sugar industry."

Other speakers discussed the position of Russia. If Russian production continued to increase it was feared that Germany would suffer. The admission of Russia into the Convention was regretted but was regarded as inevitable after the repudiation of her engagements by Great Britain. The maintenance of the present Russian bounty is evidently regarded as the great danger in the future.

George Martineau.

Reports to hand from Queensland refer to the imminence of a big strike in the cane sugar industry out there. The demands of the workers included an eight-hour day in mill and field, and a minimum wage of $7\frac{1}{2}$d. per hour, all found, or 30s. per week, for milling work. The Australian Sugar Producers' Association had so far declined to meet the men in conference. The employees concerned total 29,680 field workers and 6,726 factory hands. The latest news is, however, that the strike has been averted.

ASEXUAL SELECTION OF SUGAR CANE IN JAVA.

A RETROSPECT.

By J. Sibinga Mulder.

In Vol. I. of the *Archief voor de Java Suikerindustrie*, 1893, Kobus quoted a publication of Hubert Edson on the improvement of sugar cane by chemical selection and pointed out the necessity of adopting such a method in Java.

The first publication of Kobus' work in that direction, carried out at the East Java Experiment Station, appeared in the same journal during the years 1897 and 1898. The principle of this selection was mainly as follows : every cane field contains heavy plants as well as light ones, and experiments show that, as a rule, the heaviest plants are the richest in sugar content. According to this rule we find in every cane field plants having a relatively high saccharine content, which are at the same time the heaviest ones, plants having a low saccharine content and being at the same time the lightest ones; and every graduation of both properties between the extreme limits. If it could be proved that cuttings of the heaviest plants produce also heavy plants with a higher sugar content than that of the progeny of the light plants, we could obtain a higher tonnage of cane and a better sugar yield, just by using as seed the tops of the heavy plants, thereby excluding from propagation the less valuable individuals.

Kobus was successful in proving the hereditability of the property referred to, and he found considerable differences in the sugar content of canes from one self-same variety. He continued his experiments during a series of years and published the results obtained in a great many papers appearing in the *Archief* and in other journals.

It is true that in some cases the differences were insignificant, *e.g.*, in the case of the seedling cane No. 100; but Kobus accounted for the discrepancy in this case, inasmuch as at the outset of his experiments this cane variety had been propagated by cuttings during four generations only, and therefore had lacked the opportunity of forming variations. After having accomplished the relatively light work of laying down the principal rules according to which the asexual selection had to be made, the much more difficult task of demonstrating how to execute it in practical working had to be undertaken. It would be necessary during the harvesting of the cane to select the different plants and to pick out the heaviest ones, either at sight or by weighing them, and to use exclusively the tops of the picked canes for planting new fields. It is obvious that such a rough selection cannot meet our purpose. It is impossible to inspect properly the many millions of cane plants harvested and, even assuming that it is feasible to have a sufficient number of reliable men to inspect all the canes, the expense of the work and the great delay, which it would

occasion in the harvesting of the crop, would soon be heavier than would be justified by the better results anticipated. Further, the selection would involve the discarding of so many tops and leave so few of the rest available, that a great part of the new fields would have to be planted with ordinary unselected tops.

Kobus realised very soon that such a selection was an impossibility and suggested starting selection work in the special fields where cane was already planted in nurseries to be cut up entirely for seed in the new fields. At that time the "*sereh*" disease prohibited the propagation of the cane by using tops of ripe cane during more than a very few consecutive generations, and it had become the rule to plant nurseries from a small quantity of select sound canes, to cut up in pieces the young canes resulting from them, to plant these again in secluded parts in the mountains, safe from any risk of infection by "*sereh*" disease, and to use these canes when six months old as seed for the new fields, to supply canes for the mill.

It is evident that in such a scheme of propagation it is much easier to carry out the selection in the nurseries, and if possible in the first ones, than in the fields, since, assuming a multiplication of the cane in proportion of 1 to 8, the amount of work to be done is only $\frac{1}{8}$ or or even $\frac{1}{64}$ if the selection is performed in the nurseries instead of in the fields.

If the hereditary property is really certain to last through three generations, this scheme means a considerable saving in labour and trouble, and ensures a certainty of success.

There is, however, one serious objection, as it is still questionable whether we are entitled to judge from the properties of the unripe cane. It is not at all impossible that a young cane plant, say six months of age, will be in the best condition as to weight and sugar content, and yet be in the worst state after the lapse of another six months. It might even be that the very fact of its being heaviest and richest in sugar when six months old is an indication of its being most advanced to full maturity, so that it will already have finished its vegetation period at a time when other plants are still growing and ripening. If this plant has been allowed to remain in the field till all the canes had reached their full development, it is very probable that while at six months of age it may have been classed among the best canes, it will now have to be rejected as a bad one.

This method of asexual cane selection has never been hailed with enthusiasm; but on the other hand the collaboration of the planters has not failed when it was thought necessary to test its value in practical working. Many important sugar companies, disposing of nurseries for their fields and of the necessary number of chemists and overseers for the numerous analyses and investigations connected with the work, made experiments on a large scale, which were most

conscientiously executed. Among those we can mention the experiments made by order of the Trading Society of Amsterdam in the nurseries at Kandangan, where quite a number of overseers and chemists made laborious and accurate investigations under the able management of Mr. Dumont. The results of this expensive experiment, which to our regret, have never been published, were, in short, that nothing definite was to be concluded from them. Sometimes the unselected canes, from which only the damaged and worm-eaten ones had been discarded, gave the best results, sometimes it was the tops from the heaviest plants, which produced the best canes, and sometimes canes sprouted from tops of the lightest canes were the most favourable; but, taken as a whole, this attempt at selection turned out a failure.

Bouricius applied the selection according to weight and sugar content in nurseries at Garoet, but was likewise unable to record any notable success, which same result was also the lot of Soeters, who had tried a similar scheme in his nurseries at Bodja.

At the time of these important trials in the fields and nurseries, the theory itself did not remain unchallenged. Van Bueren, who made selection experiments so far back as 1896, criticised in an elaborate paper published in *Archief*, 1900, the—in his opinion—false basis, from which Kobus started, and believed that the figure for the available sugar, used as a criterion by Kobus, was too high; further, Van Bueren did not start from the heaviest plants but from the heaviest stalks. He demonstrated that with prolonged selection, during several generations, after the method advocated by Kobus, the amount of available sugar in the rich series constantly drops, whereas that in the poor series constantly rises, causing the difference in the two lots separated by selection to dwindle away after a few generations. Kobus opposed single individuals, possessing a relatively high percentage of available sugar, to other single individuals, possessing a low available sugar content, whilst Van Bueren determined the average content of all the canes under review and separated them into those that were over and those that were under that figure, but he too failed in solving the problem of the practical application of cane selection.

Although the sugar planters in those years had proved to be more or less blind devotees of the old ways, and had given up all further trials in this form of *selection*, they nevertheless attempted to render the idea more successful by carrying it out on other lines, and in this direction we find Kampf and Nash endeavouring to draw conclusions as to the value of the cane tops from their specific gravity.

Kampf had observed, that, especially with the variety of Seedling cane No. *33a*, many cane stalks are hollow and, when planting, the tops of these give rise to a generation of inferior cane. He took to

the idea of separating the hollow canes from the solid ones by the determination of their specific gravity. He used a molasses solution of a certain density, immersed therein the cane tops and only planted those that sank in the solution. His aim was not so much to raise hereby the average sugar content of the cane, but exclusively to plant nothing but tops of the soundest canes, which would yield a relatively better cane and sugar crop than if tops of sound and hollow canes were used together. He wrote in his article on this subject: "The selection after the sugar content must be made by means of the polariscope, but, in my opinion, a preliminary selection after the specific gravity will have to precede in order to start the second selection from none but healthy individuals."

It is very evident, that even in the ordinary way of planting without any special selection, hollow tops are invariably discarded, and it is equally evident that a better product is obtained from sound tops than from a mixture of sound and hollow ones. This is as logical a fact as the one stated by Kobus that the scions of the richest plants were less liable to attacks of disease than those of the poorest ones. The reason of this phenomenon is not far to seek, as the heaviest plants are those which are grown under the most favourable conditions, and accordingly their progeny is sure to contain the largest percentage of sound plants.

The method used by Kampf had, however, one great fault. We all know from experience, that the buds at the top end of the stalk are the most valuable for seed and that therefore the topmost portion or the white top, although the most unripe part, is the best planting material. Now the specific gravity of that particular section happens to be the smallest, being considerably less than that of the more mature parts, which have not such good properties as seed. The consequence of this peculiarity is, that when selecting the tops of every class, according to their specific gravity, there is a great chance of rejecting the most vigorous seed. Müller von Czernicki warned us also for other reasons against this method of selection, and demonstrated that by a slight difference in the manner in which a top is cut off, it may be changed from a *floater* into a *sinker* and the reverse, without of course the intrinsic value having undergone any change.

Apart from the difficulties referred to here, the selection of the cane tops after Kampf's method would meet with much trouble in practical working, since, as has been admitted by Kampf himself, it can only be applied to full-grown cane, so that it is of no value for the nurseries.

Nash also made experiments in that direction and published the preliminary favourable results at the 1907 Congress meeting at Sourabaja, but Müller von Czernicki and Straatman again uttered a

warning in a well-compiled paper (*Archief* 1908, No. 8) against the expectations which were nursed in connection with this selection method.

Van Vloten draws the conclusion from his experiments that it is not at all proved that the offspring of heavy cane tops yield a higher return of sugar per acre than those of light tops.

Many observers had devoted their attention to the fact that, as a rule, every cane plant consists of two kinds of stalks, viz., primary and secondary ones, which latter have sprouted from the covered buds of the primary stalks and therefore are the youngest. And although in case of well-developed secondary stalks, which do not offer any different aspect to the primary ones, no variation in weight or in sugar content was to be detected on close inspection, it was yet found necessary to investigate whether their progeny would offer some variation in production and in other properties.

This matter was closely investigated by that indefatigable worker, Nash, who found, just as Van Vloten had, that the progeny of primary stalks yield a better cane and greater sugar production than those of secondary ones, but he differs so far from Van Vloten in that he states, that in each class the tops having the greatest specific content will yield the best canes. Nash demonstrated his point of view in a detailed speech at the last Congress meeting at Soerabaia in March, 1911, and produced two photographs of canes from primary and from secondary tops which showed the enormous difference between both; but his assertions did not meet with much credence. For, apart from the great difficulty of distinguishing primary and secondary stalks during the busy cutting season, the Congress was rather in a sceptical mood about the results obtained by him.

Bokma de Boer, who had examined the figures for the production of the different Java estates during the years 1905-10 after Dickhoff's statistics in the *Archief*, came to the conclusion that in several districts the sugar production had increased for other reasons than those of selection, whilst Nash's estate was not among those where in latter years the production had advanced, a fact which was admitted by the owner.

Staverman concluded (and the Assembly showed by vigorous applause its agreement with the verdict) that selection had given only poor results in later years, and that not much could be expected from it; where, on the other hand, judicious manuring and tilling had produced a great improvement in a very short time, it was better to devote the greater part of their attention to that part of the work and to confine themselves, as regards selection, to a careful picking of the tops. Finally, Van der Stok, Kobus' successor as the Director of the Pasoeroean Experiment Station, delivered a speech at the same Congress meeting on the selection of sugar cane and its value in

practice. He had already stated, in an elaborate article published in *Archief*, 1910, No. 9, that it was advisable to convince oneself carefully of the reliability of the methods of selection before starting work on any large scale in order to prevent the choice of a method on a misleading or inefficient basis.

This almost mathematical essay showed us that the confidence attached by Van der Stok to *selection* was not a great one, and in his speech at the Congress he subjected the methods of asexual selection proposed in the course of years to an objective review, from which it actually appears that selection after the *habitat* of the cane is the only one which has any value for practical working. He indicated some characteristics which are required in a good and sound cane top, characteristics which were already known to the practical cane planter, and pronounced it as his opinion that a careful picking undertaken by trained hands will have an influence on production fully equal to that of the most effective combination of other methods of selection.

We have therefore come back to our starting point, *i.e.*, what we are inclined to call *natural selection* or the careful picking of the best seed, the best tops from the best fields, selected in average from the best plants, according to their different characteristics. This selection is by no means a new one, it has not been taught us by scientists, but has been evolved among practical planters from a desire to escape the losses from cane disease, and has been prompted by the wish to increase the sugar production of our fields.

Yet all the knowledge, time, work, and money spent on the investigation of a method of selection are not lost; even negative results are useful. They have taught us by keen observation the conditions for the best development of the cane, some properties of the primary and secondary stalks, and have in general increased our knowledge of the cane plant, at the same time stimulating others to observe and to investigate everything which is useful in our cultivation.

Refined sugar is entering Manchuria in large quantities from Japan and Formosa; and every effort is made by the Japanese to compete with Hong Kong refined sugar by dumping on the Chinese market cheap sugar fostered by bounties.

The 1909-10 sugar campaign in Porto Rico was handled by 43 centrals, 22 haciendas, and 65 *trapiches* or small mills. The shipments of sugar aggregated 284,522 tons, valued at £4,904,400. The average price per ton was thus £17 3s.

THE STORY OF THE RUSSIAN SUGAR INDUSTRY.*

I.

Russian industries owe a great deal to foreign enterprise and capital for their initiation and exploitation. This is notorious in connection with her metallurgical (both noble and base metals) industry, timber, and mining generally. There is one industry, however, which has been gradually developing in Russia and which may be said to be a Russian industry in every sense of the term; that is the sugar industry. It was initiated many years ago, early in the eighteenth century, by the establishment of a refinery at Moscow. The operations of this were facilitated on the part of the Government by the admission of raw sugar free of duty, besides the granting of a three years' monopoly for the sale of refined sugar. It is even stated that the Government promised, in event of the refinery finding its difficulties too great, that the importation of refined sugar during the monopoly period would be entirely suppressed. As a matter of fact this measure was taken; but soon thereafter the prohibition was transformed into the levy of an import duty amounting to 15 per cent. *ad valorem*. As the sugar was valued at that period at 5 to 8 roubles per pood, the duty made an addition of 0·75 to 1·20 roubles per pood. Later, new refineries were erected, but these had to pay full duty on raw sugar. It was about the end of the eighteenth century when a small beetroot sugar factory was erected in the Government of Tula. This was followed by the erection of several more in the first quarter of the nineteenth century.

Furthermore, the import duty on foreign sugar was permanently increased from 0·75 roubles in 1810 to 3·80 roubles in 1841. Thenceforward the beetroot factories were able to obtain fine prices for their products. Their numbers increased considerably, and whereas in the year 1825 only seven were in operation, in the year 1840 the number had increased to 143, in 1844 to 206, and in 1848 to 340.

Whilst the internal sugar consumption grew year by year and the import duties were increased on foreign sugar, this caused a great increase in the inland production, so that on the whole no Excise was paid and the Treasury gained no advantage from the increase in the consumption of sugar. In the year 1831 the import amounted to 1,453,650 poods under an import duty of 2·80 roubles which resulted in Treasury receipts of 3,706,800 roubles. This importation became 1,799,740 poods in 1840 and with an import duty of 3·80 roubles made a total of 5,778,410 roubles. It became obvious that as the sugar industry grew in Russia, the Treasury, as far as income therefrom was concerned, must die of starvation; so that in the year 1848 a very moderate Excise was levied on the sugar produced in the

* Derived from a more detailed account appearing in the "Indische Mercuur."

country, of 30 copecks, or about 7½d. per pood (36 pounds) of sugar obtained from the beet, which was for the purposes of Excise calculated on a 3 per cent. yield of sugar. Later the levy, particularly for factories producing over 500 poods, was increased, but did not exceed 60 copecks per pood in 1854, whilst the yield was legally calculated at 5 per cent. or 12 pounds of sugar per berkovitz (361 pounds). Taking into account those light burdens on the sugar produced in the country and the much heavier burden on imported sugar, it is clear that as the sugar consumption in Russia increased, the industry itself likewise increased. So we find in the year 1859, 432 factories at work, or 98 more than at the period when the Excise was established, and during the same time the production increased from 270,000 poods to 1,200,000 poods. The position of the factories had become the more satisfactory, in that the quality of the raw material had improved and considerable improvements in its treatment had been introduced, so that more sugar was obtained from the root than the small proportion on which the Excise was levied.

Some factories obtained 5 per cent. sugar from the beet, some even 6½ per cent. The importation of foreign sugar declined more and more, and the duty in the year 1859 yielded only 2,800,000 roubles against 8,000,000 roubles in 1848; so that the Government seriously considered an increase in the Excise, and after many investigations introduced in the year 1863 a completely new project of law. It soon appeared that the calculation of the Excise, according to a fixed yield, was very disadvantageous for the Treasury because manufacturers continued to introduce such improvements in the raw material itself and in the methods of treating it, that they managed far to exceed the minimum established, and the quantity of sugar they therefore produced free of any Excise whatever grew more and more. The Government endeavoured to keep step with these improvements by raising the levy from 30 to 50, to 70, and finally to 80 copecks per pood, but technique always got in front of it and the manufacturers reaped a continuous profit from the lead they held. It was in the year 1881 that the basis of the fixed yield was abandoned and a levy was made on the actual sugar produced. In order not to burden the industry too much at the beginning, the Excise in the first year, 1881, was fixed at 50 copecks per pood; in 1883 at 65 copecks; in 1886 at 85 copecks; in 1889 at one rouble, and in the year 1894, on the occasion of a general increase in the country's Excise, the Excise of sugar was raised to 1·75 roubles per pood, at which level it now stands.

The import duty on sugar from abroad, which up to the year 1856 stood at 3·80 roubles, was reduced to three roubles per pood for sand sugar and raised to 4 roubles per pood for refined sugar, then underwent a long series of changes, and finally in 1906 the rate was fixed at 4·50 copecks per pood for sand sugar and 6 roubles for refined sugar.

These vicissitudes signify but little, but the duties are so high that they practically amount to prohibition and as a consequence the importation of sugar into Russia since their imposition has been unknown.

II.

Only in years of scarcity does the Government for a time reduce the import duties in order that the requisite quantity of sugar may be brought into the country to correct the situation, and immediately this is done the frontier is, so to speak, immediately closed again by the removal of the reduction. Thus the inland trade in sugar becomes a pure monopoly and the price is maintained at a payable level, to which result the distribution of right of production amongst the various factories materially contributes. The country's production in sugar is of course larger than is required for its consumption; therefore a proportion must be exported, and the distribution of the right of production amongst the various factories caused considerable trouble in the earlier years of the industry, as also did the allocation of rights of export; because naturally the manufacturers all sought to have as large a share as possible of the high-priced inland market; but a hearty co-operation amongst the sugar manufacturers, firstly in their own initiative, and later under coercion through the intervention of the Government, has resulted in the sharing of the inland and export market for both raw sugar makers and refiners on a clearly established basis.

Whilst the Government thus ensures a wide and satisfactory basis for the industry, on the other hand it derives a direct advantage from the arrangement, because it thus secures a fine source of income from the industry which it derives through its excise of one rouble 75 copecks per pood, as the figures during the last nine years will show. The receipts from this source in the 1901-2 campaign made 80,500,000 roubles and the rise has been fairly steady up to the 1909-10 campaign to 116,500,000 roubles. It is of interest to observe here that in the year 1848 there were no fewer than 340 beet sugar factories at work, rising to 427 in the year 1862. Year by year additions were made, but they were small concerns and had only the promise of a feeble existence. This progress appears to have been arrested at the last period named, *i.e.*, 1861-2, for in that year the number of new factories was only five, whereas between 1850-51 and the period named the annual increases were never less than nine, frequently exceeded twenty, and twice rose to over thirty, the highest having been, thirty-five in 1858-9. But on the other hand, in the year 1860-61 the number of factories that disappeared began to be greater than the number of those that came on the scene. The production of sugar during the period named—1850-51 to 1861-62—was somewhat irregular, but perhaps the period is too far back to allow details of the

production to be of interest. In 1850-51 it made 800,000 poods, rising to 1,350,000 poods in 1854-5 and falling away irregularly to 987,000 poods in 1861-2.

A point to be observed also in passing is that the yield per cent. from the beetroot was very irregular. In 1850-51 it made 5·41 per cent., rising after setbacks to 6·41 in 1854-5, then falling irregularly down to 1·95 in 1859-60, after which the percentage is not given in this series of years.

A terrible crisis faced the sugar industry in 1862 when the Czar Alexander II. freed the serfs, thus depriving the factories of free labour. The result was that a large number of small factories, three-fourths of which were working without steam, had to give up, so that in the year 1871 only 180 establishments remained which, however, were better equipped for production and turned out more than the 400 small ones. In the year 1871 there was a very bad harvest. Sugar rose in price and capitalists hastened to invest in sugar factories, to take advantage of the good market. In 1872 seven new factories were built; in 1873, 16; and in 1874 and 1875 together, 17 more. Thus in the space of four years forty large sugar establishments were built and added to the producing power of the country, the difference betweeen 10,500,000 poods and 11,147,411 poods.

When the equilibrium was established between supply and demand, sugar again lost its value and fell quicker than it had risen, so that many of the establishments, both old and new, were working at a loss with the natural results. The Government, which contemplated with great uneasiness the ruin of the once flourishing sugar industry, came to its help in 1876 in order to provide an outlet for the over-production, and instituted export bounties which made up to the sugar industry the greater portion of the burden that it had to bear in point of taxes. The price of sugar remained low till 1880, but in 1881 the severe winter prevented many of the factories from working up the beet, resulting in a great rise in prices which failed to attract foreign sugar because, according to the decree of 1877 requiring the import duties to be paid in gold, the duty on foreign sugar which was nominally 2·20 roubles and 3·30 roubles per pood for brown and white sugar amounted in reality to 3·50 and 5·30 roubles, which was prohibitive. The establishment of new factories began afresh. In 1885 the production had reached the level of 29,000,000 poods or double that of four years previously, which is to be ascribed both to the increased area planted with beetroot and the larger percentage of sugar extracted therefrom. Thus we can see that the production very rapidly surpassed the consumption, so that a large quantity remained unsaleable, and prices fell so low once more that sugar could not be profitably produced. Again, on the 12th and 25th July, 1885, an export bounty was resorted to, amounting to a premium of 1 rouble per pood on sugar exported to European ports up till 1st and

14th January, 1886, and to Asiatic ports up till 1st and 14th July, 1886, the payment of the premium to cease as soon as the export exceeded 2,000,000 poods.

Although all hastened to take advantage of the provision, it did not help much, because the harvest of 1885-6 was an extraordinarily large one and instead of the inland market being relieved by the export permit, it became more overcharged than ever; so that the period for export had to be extended. Meantime the factories were agitating for a reduction in the output and an extension of the bounty system for the export. The bad prices continued through 1885 to 1888 during which 22 factories stopped working and since the Government failed to assist the manufacturers, they decided to help themselves, and on the 28th April and 11th May, 1887, 171 of the 219 surviving factories formed a syndicate with the following principal conditions:—

The contracting parties bind themselves in order to obviate the glut on the inland market during the following three years to export a portion of their production up to a certain limit. The limits need not be here specified, further than to say that over a certain production for the inland market all the rest had to be exported within a certain period, the validity of the agreement to lapse in this respect when a scarcity began to prevail on the inland market as would be shown by the price of sugar in Kieff remaining at 4 roubles 50 copecks per pood or more for longer than a week.

At this point an important provision by the Government came into operation and should be clearly set out. When the syndicate was renewed somewhat later in order to prevent the consumers paying too high a price in a period of scarcity, it was decided on the suggestion of the Minister of Finance that a reserve of 3,000,000 poods of sugar over and above the contingent should be held which in case of a bad harvest or an extraordinary rise in price might be placed on the inland market. Further, the price at which sugar might be sold was fixed at a maximum rate of 5 roubles for the winter months and 5 roubles 25 copecks for the summer months, whilst the previous maximum price had been 4 roubles 65 copecks for the whole year. Since in this year, 1894, the excise on the sugar was fixed at 1 rouble 75 copecks, the change in the maximum price makes a reduction to the consumer of 40 copecks in the winter and 15 copecks in the summer. Otherwise the position of the Russian Sugar Syndicate remained practically as before. The number of adherents grew. It began with 171 factories in 1887, or 78 per cent. of the 219 then existing, and grew to 212 out of 224, or 93·5 per cent., so that the master result was practically obtained by making the whole inland market and the regulation of the export one great monopoly.

III.

Arrived at the period 1894-5 we may state that the price of sand sugar was 7 roubles 90 copecks maximum and 5 roubles 10 copecks minimum. The corresponding figures in 1886-7 were 3 roubles 97 copecks and 2 roubles 99 copecks, finishing up with 4 roubles 75 copecks and 4 roubles 24 copecks in 1894-5. At this period 1894-5 the disguised premium was received only for sugar sold inland and the quantity for each factory of the syndicate was a fixed one. The export sugar was produced in Russia at a high cost and had to be sold at a low price against the competition of beet sugar producing countries in the open market, thus involving a loss on exports, which was made up by the advantage obtained on the inland market. Therefore it was arranged that this advantage should not be too pronounced. The Government reserved the right, when the price of refined sugar and sand sugar at St. Petersburg stood at 6 roubles to 6 roubles 60 copecks and at Kieff and Odessa at 5 roubles to 5 roubles 50 copecks, of reducing the import duty on foreign sugar to 1 rouble 50 copecks per pood.

Such a case arose in 1892 when the Government bought 1,685,000 poods of sugar abroad and sold it at a fixed price indifferent to the district, between 5 roubles 10 copecks and 5 roubles 60 copecks per pood. Thus the syndicate cannot make its great weight prevail to obtain an excessive price. It was naturally discontented, observing that there was a profit inland but a loss on the export movement; besides there was always a number of factories outside the syndicate which managed to take advantage of such sacrifices as it had to make. These paid no contribution to the syndicate but sold their sugar on the inland market, which they were able to do cheaper than the syndicate factories. In the first three years the production of the syndicate increased by 22·7 per cent. and that of the outsiders by 48 per cent. The latter increased in numbers with the advantage of being free to handle their own business, which frequently resulted in low prices. Again in the year 1894-5 there was a large sugar production and prices fell so low in Russia and other countries that some manufactories were unable to sell their goods and had to leave the syndicate. Thus the industry stood in face of a crisis and after many ways out had been sought the Government decreed on the 20th November, 1905, the following regulation, to last at first for three years, but it was subsequently extended.

"The Committee of Ministers will fix every year the quantity of sugar which the sand sugar manufacturers and the refiners may put on the inland market and which shall pay an excise of 1 rouble 75 copecks per pood. In addition, the quantity of sugar shall be fixed, besides a so-called inviolable stock at the factories to be held in order, in case of scarcity, to be placed upon the inland market. The same committee shall fix every year the price beyond which the said reserve

may be broached and the conditions under which it may be placed on the inland market.

"When a manufacturer sells more on the inland market than his contingent, he shall pay, besides the excise of 1 rouble 75 copecks, an extra excise of the same amount making a total of 3 roubles 50 copecks. All sugar that is exported shall be free of duty but will be entitled to no premium. When the inviolable reserve is reduced by sale on the inland market, then it must be re-integrated at the beginning of the succeeding campaign, and every year the old stock must be replaced by sugar of new manufacture, so that the same sugar is not held over from year to year in the warehouses."

Through this regulation no manufacturer can escape with a high hand from the limits of his contingent, and it was so arranged that small factories which deliver 60,000 poods of sugar per year can sell all on the inland market, whilst the percentage that was allowed to the larger factories declines in proportion as the production increases, with this condition, that the factories could sell more inland when they produced more. The basis on which the contingent was calculated can best be understood by considering the campaign of 1900 and 1901. In that year the contingent was 36,000,000 poods and the inviolable reserve 3,500,000 poods according to the official estimated quantity required for consumption.

The Minister of Finance receives at the beginning of the campaign from the Central Bureau of the Sugar Manufacturers a report on the area planted with beetroot, on the progress of its growth, and so on, and estimates according thereto the probable production. Further he calculates how much per cent. the production over 60,000 poods for each factory may exceed that quantity. The presumable production was reckoned at 53,369,187 poods, including 2,800,977 poods taken over from the preceding year of inviolable reserve and 603,276 free reserve. The real production amounted to 53,408,950 poods, working out to about the calculation. The number of factories was 274. Each had a right to 60,000 poods, so that we have $60{,}000 \times 274 = 16{,}440{,}000$ poods and there remained 36,968,958 poods to dispose of with a theoretical balance of 19,560,000 poods, whilst 3,500,000 poods had to be held as inviolable.

Thus every factory takes part first of all in the 60,000 poods and then in the 59 per cent. of its production over the 60,000 poods contingent, so that a factory which makes 60,000 poods only can sell its total production in the interior, whilst one that produces 120,000 poods, calculated as follows:—

$$60{,}000 + \frac{60{,}000 \times 52{\cdot}9}{100} = 91{,}740.$$

and one manufacturing 200,000 poods, as follows:—

$$60{,}000 + \frac{140{,}000 \times 52{\cdot}9}{100} = 133{,}060.$$

Thus we see that the more a factory produces, the more it can put on the inland market, although the proportion of this total production appears less. By this regulation the stimulus to production remains, whilst the inland market is protected from overloading, and great fluctuations in price, thereby avoiding an excessive speculation. The Government allowed the price limit to go slightly lower every year so that the consumers could buy their sugar cheaper, thereby getting the advantage of improved technique in the factories and in the fields. Thus the consumption of sugar grew greatly in Russia, assisted by the improved ways of communication, the opening of the Siberian markets and the reduced consumption of alcohol which was to some extent replaced by tea which assisted the demand for sugar.

It is shown that in the course of years the contingent for inland consumption steadily grew and how this was so accurately reckoned that it was hardly necessary to use the reserve and only slightly to call on the free reserve for the inland consumption. The system worked very well, until in years of great harvest, when there resulted an over-production which in the year 1903 enabled the export to take place to the countries included in the Brussels Convention, but still a large quantity remained unsold to be carried into the succeeding campaign with unhappy results. Subsequently the minimum production that could be entirely sold on the inland market was raised to 80,000 poods per factory. But the course of Russian sugar production since the campaign 1904-5 is sufficiently in the recollection of the sugar world to make a recapitulation of the events connected with it unnecessary. The foregoing will indicate very clearly that the Russian sugar industry, begun on a very small scale, has developed with steadiness on the whole in all its branches, and is a most remarkable example of an industry at the same time fostered in its enterprise and limited in its activity by a paternal government.

THE GASOLINE MOTOR AS A CABLE TRACTOR FOR CANE CULTIVATION.

By J. H. Wale, Guantanamo, Cuba.

A machine which is destined to become largely used in cane cultivation all over the world is the Eastman Cable Tractor, which has been recently introduced to the beet growers and sugar planters in the States, and which has been very favourably commented upon in the American sugar papers. A few weeks ago the writer was given a demonstration of the powers and adaptability of the machine at Audubon Park, La. It is a light machine (7 tons fully equipped) with an immensely powerful motor, an equipment capable of the heaviest service and yet able to negotiate bridges and roads without

injuring them. The fuel used is either kerosene, distillate or gasoline with superheated air, and the engine is of 4-cylinder, 4-cycle type, rated 85 h.p. at 600 r. p. m., with cranks set *desaxé*, sight oil feed, governor control, and speeds, either forward or reverse, of 2, 3 and 4 miles per hour. Design, material and workmanship are perfect. The ignition system, differential gearing, clutch, cable system and wheel tread are all original. The cable is taken up in 4 separate well-fitting grooves on two drums, set tandem, which carry all the strain and maintain a perfectly even steady pull with no wear and tear on the cable, which is afterwards automatically wound on a reel mounted in front; and the machine is adapted for either working facing the field under cultivation, or, by use of the side pulley, at right angles to the cut, which gives it an additional value in working on narrow headlands. The tanks carry enough oil and fuel for 2 days' work. Points which appeal to the practical agriculturist are the machine's general all-round efficiency, its cheapness of operation, and the ease with which it is handled. It has been used in general farming in California for the last 2½ years with entire success, and it will readily be seen to what an infinite number of uses a machine of this description may be put on a sugar plantation, particularly in those countries where labour is a high-priced problem, and where every effort has to be made in cultivation and manufacture to produce a crop at the lowest possible cost in order to show a balance of profit.

As a clearing implement it has a record, made under expert control, of having pulled 51 trees in 30 minutes. It will operate a gang plough or harrow of any make and may be used for levelling, lining or broadcast fertilizing. In straight planting on irrigated plantations it may be used for furrowing, and on unirrigated plantations for furrowing and cultivating, the only device necessary for the latter operation being a light cross-pole rigged in front of the gang and with a hook at each end to carry over the idle cable in its proper returning row. It may be used for fertilizing under the same conditions. Its light control and inexpensive operation bring it into line for haulage of seed, fertilizer, cordwood, &c., and, during the crop, for hauling out cars or sleds to the main track or to the mill. During the off season the machine would have unlimited usefulness as a stationary motor by merely unshipping the reel and mounting a pulley on the side shaft which is specially prepared for that purpose, or it might be used for road building or repair, house moving, railroad grading or any other operation requiring power.

Mr. D. L. Thomson, A.M.I.M.E., consulting sugar engineer of San Juan, Porto Rico, has recently accepted the position of consulting engineer in Porto Rico to the Krajewski-Pesant Co.

THE BRITISH WEST INDIES.*

Some Geographical Data.

Trinidad.

Trinidad and Tobago form for administrative purposes one colony. The former lies about 16 miles to the eastward of Venezuela; it is about 48 miles in length and some 35 miles in breadth, the total area being 1754 square miles, or the size of Lancashire. The chief town and seaport is Port-of-Spain (population in 1901, 54,100); it is looked on favourably by sailors as a place of call, as it is out of the range of cyclones and the harbour is being steadily improved. The next town of importance is San Fernando (population, 7613) about 30 miles south of Port-of-Spain. There are several rivers in the island but none of them of any size or navigable, and all of them run east or west. Apart from the pitch lake, which brings in a revenue of nearly £50,000 a year, the industries of the island are mainly agricultural, sugar taking the lead. The amount exported in 1909-10 was 45,330 tons. A new industry has however sprung up lately, several oil companies having been formed to work the marvellously rich petroleum deposits found in certain parts of the island.

The climate of Trinidad is healthy and by no means hurtful to Europeans, providing they take ordinary precautions. The average rainfall for the 46 years, 1862 to 1907, was 72·39 inches. The temperature is remarkably equable, ranging between 70° and 88° F.

Tobago is 26 miles long and 7½ miles at its greatest breadth, and has an area of 114 square miles, or 73,313 acres, 10,000 of which are under cultivation. Scarborough (population in 1901, 769) is the principal town. Sugar, rum, molasses, cocoanuts and live stock form the principal articles of export.

Windward Islands.

These comprise the four islands of Grenada, St. Lucia, St. Vincent, and Barbados.

Grenada is 76,548 acres in extent, or slightly larger than Tobago. Its largest town, St. George's (population, 5,198), has a fine harbour and offers considerable inducement as a port of call and coaling station. The island is mountainous and abounds in streams and in mineral and other springs. Agriculture is the staple industry; but Grenada, unlike its neighbours, has long ceased to be a sugar producing colony, cacao being the principal product.

St. Lucia is 24 miles in length and 12 at its greatest breadth; its circumference is 150 miles and its area 233 square miles. The capital

*Compiled from "West Indies in Canada," an interesting brochure, just issued by the Imperial Department of Agriculture, Barbados, with the object of placing manufacturers and merchants in Canada in possession of reliable statistics and facts relative to the present development of the British West Indies and British Guiana. It can be obtained from Dulau & Co., London.

is *Castries*, which contains a population of 8,000, and is said to have the best harbour in the West Indies. Another town of importance is Soufrière with a population of 2,500. The island is mountainous and possesses scenery of peculiar beauty and even grandeur, the most striking feature being two cone-shaped rocks rising sheer out of the sea to a height of nearly 3,000 feet. Sugar, cacao, limes, logwood, and spices are the principal products. There are four sugar usines, all fitted with modern machinery.

St. Vincent is 18 miles in length, 11 in breadth, and contains 85,000 acres. The 1911 census gave 41,877 as the population. Kingston, the capital is situated on an extensive bay at the south-west extremity of the island, its population being 4,300. St. Vincent possesses striking natural features, and rivals Dominica and Grenada in the beauty of its scenery. A backbone of high mountains runs throughout its length and terminates at the northern end in the remarkable inactive volcano "La Soufriére." The southern and western coasts are fringed by excellent deep water bays.

The climate is very pleasant in the dry season (December to June). In the wet season it is damp and hot but not unhealthy and fever is almost unknown. In fact St. Vincent may be considered one of the healthiest islands in the West Indies. The average rainfall for the last 17 years has been 105·28 inches. Cotton, arrowroot, cacao, and sugar are the chief products.

Barbados.

Barbados is the most easterly of the Caribbee Islands. It is nearly 21 miles long by 14 wide, and contains an area of 106,470 acres or about 166 square miles. Bridgtown, the chief town and port, is situated on Carlisle Bay, an open roadstead much exposed to wind from the south and south-west. There is, however, an inner harbour protected by a structure called the Molehead. The population of Bridgtown, according to the census of last April, is 116,648, while that of the whole island has just been returned at 171,982. The island is almost encircled by coral reefs which in some parts extend nearly three miles to seaward and constitute a danger to navigation. The greater portion of the island is of coral formation, the exception being the north-east corner which is composed of sandstones, clays, and infusorial earth. The water supply is abundant and unique, the water being pumped from a great depth and conveyed by means of pipes all over the island.

Sugar is the island's most valuable production; in 1910 there were 332 sugar works in operation, producing 39,899 hogsheads of sugar and 77,722 puncheons of molasses.

Internal communication is good, there being 24 miles of light railway, as well as an efficient tramway service in Bridgtown and its suburbs.

Leeward Islands.

Antigua is about 54 miles in circumference and its area is 108 square miles—about half the size of Middlesex. It is the seat of Government of the Leeward Islands. The Islands of Barbuda and Redonda are dependencies of Antigua, and have an area of 62½ square miles. The total population of all three islands is about 35,265, according to the latest census. St. John's, the chief town, has a population of 9,262.

There are no rivers and but few springs; consequently the islands suffer during drought. They are less mountainous than most of the others of the Leeward Group, the highest peak being but 1,360 feet. The average rainfall, based on the period of 1874-1910, is 45·03 inches. The climate is healthy and during the winter months very pleasant; during 1910 the temperature varied between 66° F. and 89° F.

The principal exports are sugar and molasses, the average annual production ranging from 12,000 to 15,000 tons. Formerly only muscovado sugar was made, but of late years considerable advances have been effected in methods of manufacture, and the former wasteful and antiquated method is being replaced by the modern central factory system. There are now two central factories in the islands, the larger of which has recently been considerably extended; together, they are capable of turning out some 9000 tons of grey crystals per annum. The total sugar export of 1910 amounted to 13,509 tons, of which 6,415 tons was crystals and 7,094 muscovado.

St. Kitts-Nevis consists of the islands of St. Christopher (St. Kitts), Nevis, and Anguilla with their several dependencies. The total population according to the latest census is 43,303, and the area 150 square miles. St. Kitts has an area of 68 square miles, being about 23 miles long. Its capital, Basseterre, has a population of 10,000. Nevis is 47 square miles in area.

The production of sugar, molasses, and rum, and the growing of cotton form the principal industries of the two larger islands. About 17,000 acres are under sugar cane cultivation, and the sugar exports during 1909-10 amounted to 12,510 tons of sugar, 2682 puncheons of molasses, and 127 puncheons of rum. A modern central sugar factory is in course of erection on St. Kitts; and there are botanic and other experiment stations maintained under the Imperial Department of Agriculture in both St. Kitts and Nevis.

Jamaica.

Jamaica is the largest island of the British West Indies, being 144 miles in length and 50 in extreme breadth, and containing about 4,207 square miles, or say half the size of Wales. It is very mountainous, the main ridge running east and west with numerous subsidiary ridges, terminating in the famous Blue Mountains in the east, the

highest peak being 7,363 feet high. There are numerous rivers and streams, with a rapid fall for the most part, and consequently not navigable. Kingston, the capital, had a population of 48,504 in 1891; it is situated on the south coast and has a fine harbour.

It is estimated that Jamaica contains 2,692,480 acres, of which 2,612,400 are available for cultivation. Of this area 894,638 acres were returned as under cultivation in 1910. The area under sugar cane was 30,153 acres; and the exports of 1909-10 amounted to 9,894 hogsheads of sugar, valued at £118,733, and 16,528 puncheons of rum, valued at £234,151. There is a great variety of climate; the mean temperature of Kingston varies from 87·8°F. in the day time to 70·7°F. at night. But a change of 10° or 15° in temperature can be attained by a ride of three hours from Kingston into the hills. The mean annual rainfall varies throughout the island from about 34 in. at sea level to as much as 240 in. on the northern slope of the Blue Mountain range.

British Guiana.

British Guiana includes the old settlements of Demerara, Essequibo, and Berbice, and has a sea board of about 270 miles with a mean depth inland of about 500 miles. It is therefore equal in extent to the combined size of England, Scotland, and Wales, or 90,000 square miles. About 130 square miles are under cultivation, and the remainder is densely covered with exuberant primæval forest, except in those parts where there are broad open flats and undulating grassy plains or savannahs and mountainous grass-clad country.

The coast lands are flat, and are for the great part swampy. They are slightly below the level of ordinary spring tides, so that sea walls and other defences have had to be constructed to protect the settled parts from being flooded by high tides. They form part of an alluvial belt which rises gradually from the sea level and extends inland for a distance varying from 10 to 40 miles. It is on this belt that all the sugar estates and the greater part of the cultivated areas are situated.

The alluvial belt is succeeded by a slightly elevated and undulating belt composed of sandy and clayey sedimentary soils. It is traversed in some places by sand dunes which rise from 50 to about 180 ft. above the sea level. Grass-covered downs occur on the banks of some of the rivers that traverse this region, but the greater part of the tract consists of high forest.

Beyond these belts, southwards, the country rises between the river valleys, which are in many parts swampy; and as it approaches the sources of the larger rivers attains a height of about 900 ft. above the sea level on the western boundary. It is diversified by numerous low hills and valleys and contains three principal mountain ranges. In the southern and western parts there are many scattered, isolated mountains. This elevated portion

occupies about three-fifths of the area of the colony and, with the exception of large, flat, grass-clad plains or savannahs, is entirely forest clad.

The colony is traversed by many large rivers, which, with the numerous tributaries and branch streams, form a vast network of waterways that, in the absence of roads, furnish a ready, if somewhat difficult, means of access to the interior. All the rivers are impeded above where the tide reaches, at varying distances from the coast, by numerous rapids, cataracts and falls, which render the navigation of the upper reaches difficult and in some parts dangerous.

The largest of these falls is the Kaieteur on the Potaro, which has a width in the rainy season of nearly 400 ft. with a perpendicular drop of 741 ft. It is succeeded for about three miles below by a series of very large cataracts having a further drop of 81 ft.

The colony is divided into the counties of Demerara, Essequibo, and Berbice. The county of Demerara is the most important, although it is by far the smallest, for in it is placed Georgetown, the capital and principal port of the colony. This town is situated at the mouth of the Demerara river and has a good harbour. Vessels of fairly large size can come into the harbour at any state of the tide, but there is a bar near the lightship which is an obstacle to vessels drawing more than 19 ft. 3 in. of water. Georgetown is well laid out on flat land, with wide streets running at right angles to each other. The streets are lit with electric light and electric tramcars run throughout practically the whole town. It possessed a population of 57,528 at the last census, taken this year, and the only other town in the colony is New Amsterdam, the former capital and chief port of Berbice. It is situated about five miles from the mouth of the Berbice river on the eastern bank, and has a population of 7835.

There are many large and small villages scattered along the sea-coast and on the margins of the rivers near the sea. The villages have a total estimated population of 87,000. The estimated population of British Guiana is 295,750, exclusive of aboriginal Indians who are supposed to number 12,000.

The climate is hot but not unhealthy, the mean temperature throughout the year being about 80° F. The annual rainfall for the past 30 years has averaged about 92·9 ins. in Georgetown. In different districts of the colony it varies from 88 to 143 ins.

At present the sugar cane, with its products, is the most important of the agricultural resources. There are forty sugar estates, with a total area of 154,160 acres. Of this area 69,737 acres are under sugar cane, and 4940 under rice and other products, whilst 79,483 are being used as pasture lands. The acreage of land under sugar, despite low prices and attacks of diseases in past years, is practically the same as it was twenty years ago, while the average crops of sugar and its by-products are the same, or possibly somewhat higher. Fifty years

ago, the number of sugar estates was about four times what it is to-day, but low prices and keen competition have necessitated a materially lessened cost of production, and a centralized management in large factories.

During 1910-11 the colony exported $100{,}954\frac{5}{9}$ tons of sugar, 2,515,176 proof gallons of rum, 179,163 gallons of molasses, and 9230 tons of "molascuit." The bulk of the sugar now made is high-class vacuum pan sugar for refining purposes, while certain quantities of the far-famed "Demerara crystals," the "vintage" product of the Bourbon cane, are still exported.

ON THE PRESENCE AND THE DETERMINATION OF NITRATES IN CANE AND BEET MOLASSES.

By H. Pellet and Ch. Müller.

Beet molasses contains a certain amount of nitrogen in a variety of forms. According to E. Sellier the nitrogen may be present as: (1) as protein substances, *e.g.*, albumins, albuminoses, and peptones; (2) as lecithin bases, *e.g.*, betaïne and choline; (3) acid amides, *e.g.*, leucine, tyrosine, aspartic acid, and glutamic acid; (4) as amides of acid amides, *e.g.*, glutamine and asparagine; (5) as ammoniacal nitrogen; (6) as nitric nitrogen; and (7) as nitrous nitrogen.

Different authors have found that the quantity of total nitrogen contained in beet molasses varies considerably at different periods. It is certain that formerly with bad quality beets the quantity of nitrogen was quite high; but in recent years, with the present improved quality of the root of different sugar producing countries, this has been reduced.

It is especially the amount of nitrates that has been considerably diminished. It may be recalled that Dunbrunfaut drew attention to the presence of considerable quantities of nitric nitrogen in molasses, and that some investigators have thought that this product might afford a source of nitrates for transformation into potassium nitrate for utilization in the manufacture of gunpowder.

But now the amount of nitric nitrogen in the beet is comparatively small, so that the proportion of potassium nitrate never exceeds 0·04 to 0·06 per cent. on the dry substance, or 0·01 to 0·016 on the roots, and is recoverable in the molasses.

Cane molasses likewise contains nitrogen in different forms; but so far we have not seen in any of the more recent papers published by Prinsen Geerligs, Tervooren, Hazewinkel, or Noël Deerr the presence of nitric nitrogen pointed out in this by-product.

We have carried out experiments demonstrating the presence of a small amount of nitric nitrogen in cane molasses, and a number of determinations have been made.

We have been obliged to use the following method, for it was found difficult, or even impossible, to work directly according to the classical method of Schlösing. It is necessary to separate the nitrates from the greater part of the foreign substance, and in so doing we applied the general procedure of Boussingault, namely, dessication of the material, and extraction of the nitrates by 80 per cent. alcohol. In this way the nitrates are easily dissolved, while the greater part of the foreign matter, organic as well as mineral, interfering with the determination of the nitrates by Schlösing's method is left insoluble.

Determination of Nitrates in Cane Molasses.

Take 20 grms. of molasses, and 40 grms. of pulverized pumice-stone previously passed through a sieve. Mix well in a nickel capsule, add a little boiling distilled water, and dry in the oven. Weigh the capsule and its contents, afterwards removing the residue as completely as possible. Now weigh the capsule, when the difference between the two weighings will give the amount of the residue. For example:

Weight of the dry matter + capsule + stirrer ..	162·500
Weight of the capsule empty + stirrer	105·170
Weight of dry matter	57·330

Of this residue weigh exactly half (*i.e.*, 28·665 grms., corresponding to 10 grms of molasses), and introduce this amount, after well pulverizing, into a 300 c.c. flask together with 200 c.c. of 80 per cent. alcohol (obtained by mixing 165·2 c.c. of 95 per cent. alcohol with 34·8 c.c. of water). Allow the liquid to stand for 12 hours, agitating frequently, at the end of which time filter. Of the filtrate take 100 c.c. in a round-bottomed flask, expel the alcohol on the water-bath, and connect the flask to the Schlösing apparatus. Determine the nitric nitrogen in the ordinary way, *i.e.*, after reading the volume of gas, absorb the nitric oxide liberated by means of a small crystal of ferrous sulphate, and again read the volume of gas. From the volume of nitric oxide liberated, the percentage of potassium nitrate in the molasses is calculated.

*Pozzi-Escot's method in which the nitrates are reduced to ammonia.**

After expelling the alcohol on the water-bath, connect the flask to an ordinary apparatus† for the estimation of ammonia. In doing this, the flask should be fitted with a two-holed rubber stopper; the first hole serves for a tube to carry off the ammonia formed by the reduction of the nitrates, and should not protrude further than the bottom of the rubber stopper; the second hole carries a glass tube reaching within about an inch of the bottom of the flask, while the upper end is united to a funnel by means of a rubber tube, closed by a Mohr pinch-cock or a screw-clip. Into the flask now put:

* Bulletin, 1909, 457.

† Using preferably a metallic condenser.

(1) 5-6 grms. of fine aluminium clippings;* (2) 2 c.c. of a concentrated solution of mercuric bichloride; (3) 100 c.c. of distilled water; (4) 2 to 3 pieces of zinc to facilitate boiling; and (5) a little vaseline.

The flask is closed by the two-holed rubber stopper, while the extremity of the exit tube of the condenser is inserted in 20 c.c. of a 35 per cent. solution of sulphuric acid, coloured by a few drops of neutral litmus solution. A brisk reaction soon commences, especially if the flask is slightly warmed,† and hydrogen is freely evolved. When the reaction has subsided, a solution of 35 Bé. sodium hydroxide is added through the funnel, and heating meanwhile recontinued, so as to avoid absorption and expel all the ammonia formed at the expense of the nitrates.

Two-thirds of the liquid are distilled, and then a few c.c. of a solution of sodium hypophosphite are added through the funnel in order to destroy any ammonium-mercuric compounds that may have formed. Finally the distillate is titrated with a solution of sodium hydroxide corresponding in titre with the sulphuric acid used, but in the case of cane molasses, to obtain greater accuracy, weak standard solutions should be used.‡

Then the quantity of nitric nitrogen is calculated from the following equation: 35 grms. of $H_2SO_4 = 60{\cdot}716$ of $NaNO_3$; and 10 grms. of N; that is, 1 c.c. of 35 per cent. H_2SO_4 correspond to: 0·060716 $NaNO_3$; or 0·072144 of KNO_3; or 0·010 of N.

We have made a number of determinations of the nitrates in the cane molasses of two campaigns, and calculating as potassium nitrate per 100 grms. of molasses we have found the following figures:

Campaigns.		Schlösing's Method.		Pozzi-Escot's Method.
1909–1910	.. .. ..	0·45	....	0·50
1909–1910	.. .. ..	0·41	....	....
1910–1911	.. .. ..	0·50	....	0·50

These results agree very well; but to have greater accuracy in titration a fairly dilute standard sulphuric acid solution, viz., 3·5 per cent., and 10 grms. of the sample, should be used.

On calculating the quantity of potassium nitrate on the cane itself, about 0·020 per cent. is found, which is an amount appreciably lower than that still found in the beet, namely about 0·045 to 0·060 per cent.

These results were obtained on Egyptian molasses; and it would now be interesting to proceed in the same way to see if the molasses of different countries also contain potassium nitrate, and in which proportions.

* Aluminium powder is of no use, as it produces too much froth.

† The operation should not be hastened too much.

‡ A blank determination should be made for all the reagents used, and if necessary a deduction made.

RESULTS OF DECOLORIZATION EXPERIMENTS WITH "EPONITE."*

By H. C. Prinsen Geerligs.

Recently an article was published by Strohmer (this *Jl.*, 1911, 34-36), in which a new decolorizing material for sugar juices, named "Eponite," was favourably described. It is self-evident that a recommendation from such an authoritative source was inducement for every one occupied in the manufacture of white sugar to make experiments with the new decolorizing agent, as animal charcoal always involves much trouble, and, moreover, cannot be regarded as a cheap material.

I have also made some experiments; which, however, have not caused me to entertain much hope that this material will be of use to the sugar industry; and I learn, further, from some foreign refiners that they are not likely to take up the use of this substance.

At the meeting of the Technical Society of Beet Sugar Manufacturers and Refiners, held at Rotterdam, on the 22nd of May, Mr. A. Spakler, an Amsterdam refiner, communicated the results of experiments which he had made in his factory with "Eponite." He came to the conclusion that taking the total cost of decolorizing with animal charcoal as 1, then that of "Eponite" is 1·7, and that of "Blankit" is 2·0.

Further, he stated that "Eponite" was not to be recommended for raw sugar factories making white sugar, on account of the fact that this decolorizing material is very fine, and passes to a more or less extent through all filtering materials.

Hence there appears in the juice or syrup a heavy black cloudiness, which naturally exerts a highly detrimental influence on the colour of the product.

In this way, therefore, a little of the colour in solution is removed; but more than as much suspended matter is introduced, so that the final effect is far from favourable.

These results, obtained by Mr. Spakler on the large scale, confirm my own laboratory tests, in which even the finest paper through which a concentrated solution was capable of being filtered let through some of the carbon. How much more readily would this happen if palm fibre were used as the filtering medium, or simply if the juice were clarified by subsidence!

The same objection is attached to another decolorizing material that was given me to test two years ago. This was a very fine carbon, originating from the manufacture of potassium cyanide from potassium ferrocyanide; and was distinguished by an extraordinarily great decolorizing power. Similarly, this powder was so fine that it ran through the filter in large quantity, and for this reason could not be considered for use in the sugar industry.

*Translated from the *Archief* for this *Journal.*

DETERMINATION OF SULPHURIC ACID IN SOILS.

By P. DE SORNAY,

Assistant Director of the Station Agronomique, Mauritius.

When publishing our "Study on Soils," it occurred to us to show that the usual method of determinating sulphuric acid in soils is not capable of indicating all the sulphur at the disposal of the plant.

As is well known, sulphur is one of the principal elements necessary for the life of the plant, and if we compare the phosphoric acid and sulphuric acid taken up from the soil by our different varieties of cane, we shall see that the amount of the latter in a number of cases is much the higher.

In Hawaii, the contrary is to be observed for the cane, while the leaves give about the same results as in Mauritius.

	Hawaii.						Mauritius.							
	Variety X.		Bourbon Rose.		13 Varieties.		Louzier.		Big Tanna.		Port Mackay.		Branchu.	
	SO^3	P^2O^5	SO^3	P^2O^5	SO^3	P^2O^5	SO^3	P^2O^5	SO^3	P^2O^5	SO^3	P^2O^5	SO^3	P^2O^5
Cane .	6·89	6·81	4·98	7·04	4·70	7·27	9·70	3·63	8·88	3·41	8·60	3·73	6·29	4·10
Leaves	5·54	1·26	5·85	1·32	6·84	1·38	6·79	2·82	3·07	2·69	3·35	2·51	4·42	1·80
Total. .	12·43	8·07	10·83	8·36	11·94	8·69	16·49	6·49	11·99	6 10	11·95	6·24	10·67	5·90

This fact has always struck us, and we have pointed it out in our pamphlet; moreover, we have continued our researches on the content of sulphuric acid in soils when we have been engaged in analysing them.

It is certain that the quantity of sulphuric acid necessary in the soil is quite indefinite; but all plants contain sulphur, and have need of it.

Sulphur is met with in soils in the form of sulphates. Rain water is one of the sources of sulphur in soils, while it may also come from organic débris. From analyses which we have made it was found that the rain water of Mauritius contains on the average (of five districts) 3·034 mgrms. of sulphuric acid per litre, or 12·137 mgrms. of sodium sulphate. This according to the figures for the rainfall for Mauritius during 1862-1900 makes an annual amount of 26 kilos. of sulphuric acid, or 108 kilos. of sodium sulphate per acre. Hence this is an important source of the sulphur present in soil.

In the organic form sulphur comes from the débris of the vegetation existing in the soil. This sulphur probably undergoes different oxidations which cause it to pass to the state of sulphate, in which form it is then absorbed. In general, the migration of sulphur follows

that of nitrogen, the plant in part utilizing it in the formation of the albuminoid molecule. In his remarkable work on the "Composition and Requirements of Cereals," Joulie clearly explains that the sulphur is a constitutive element of the plant, albuminoid matters being unable to form in its absence.

According to the mode of effecting solution, and the method of determination, the sulphur in these two forms may escape in analysis, and this is what is shown by the figures which we have obtained in our experiments.

If solution of the soil is effected by concentrated nitric acid, and the sulphuric acid is precipitated by barium nitrate, in most cases no sulphur will be found, while if it is found it must be present in quite large proportions in the sample being examined. Quite contrary to this, solution by hydrochloric acid indicates a greater proportion of sulphuric acid.

The following comparative analyses giving percentages of sulphuric acid on the soil show this:—

	Using Nitric Acid.	Using Hydrochloric Acid.
1	Traces	0·151
2	Traces	0·158
3	0·031	0·140
4	0·394	0·432
5	—	0·110
6	0·164	0·205
7	Traces	0·120
8	Traces	0·116

The high proportions of iron and alumina in our soils can be the cause of insufficient solution when nitric acid is employed, and the relation found between the different figures would appear to bear out this hypothesis. Iron and alumina being more easily attacked by hydrochloric acid, it is possible that the sulphates should likewise be more readily dissolved.

It seemed interesting to investigate if such were the case, and this is how we proceeded: After the addition of nitric acid, the insoluble residue of the soil was treated by hydrochloric acid, under the same conditions as with nitric acid, the elements being determined in the filtrate. The results given are in percentages on the soil:—

	Using Nitric Acid.	Using Hydrochloric Acid.	Iron.	Alumina.	Total.
1	Traces	0·151	18·72	9·28	28·00
2	Traces	0·158	17·93	7·47	29·00
3	0·031	0·140	19·80	20·30	40·10
4*	0·394	0·432	1·60	1·26	2·86
5	—	0·110	20·08	15·00	35·08
6	0·164	0·205	20·08	15·00	17·72
7	Traces	0·120	15·63	14·07	29·70
8	Traces	0·116	17·91	14·19	31·70

* Chalk soil, close to sea.

In the first two cases we only find traces against 0·151 and 0·158 per cent., while in numbers 3 and 6, 22 and 80 per cent. of the sulphur found when hydrochloric acid is used is indicated.

Calcination always gives a higher sulphuric acid figure, by reason of the transformation of the organic sulphur to the state of sulphates during combustion, and further it facilitates the attack of the soil.

We had occasion to verify this fact in our pamphlet, and these are the results which we found in percentages on the soil:—

Calcined Soil.		Non-calcined Soil.
0·205	..	0·100
0·051	..	0·025
0·060	..	0·043

Here again the losses may be appreciable, since during calcining the pre-existing sulphates can be transformed to the state of sulphides in consequence of the reducing action of the carbon. Further, a part of the sulphur combined to the organic matter can be volatilized before being oxidized and fixed.

Joulie, who has worked most on this question, gives two methods which he calls "alkaline combustion" and "nitric combustion." They are applied particularly to the analysis of vegetables, and it is not necessary to adopt them entirely for our different soils. Therefore, we have simplified the mode of working in the first method.

Our procedure, which consists in adding potassium nitrate to the soil, has given good results, and some of the figures obtained are summarized in the following table, being expressed in percentages on the soil. In this table, we have also given values for the black matter (humus), since it seems that there is a correlation certain between the content in black matter (humus) and the loss of sulphur in our soils:—

		Calcined.		Calcined with potassium nitrate.		Black matter (humus).
1	....	0·137	....	0·151	....	0·26
2	....	0·142	....	0·158	....	0·11
3	....	0·059	....	0·140	....	1·16
4	....	0·332	....	0·432	....	2·48
5	....	0·079	....	0·110	....	1·34
6	....	0·165	....	0·205	....	0·79

Still, we have several times observed that the sulphuric acid values were the same with and without the addition of potassium nitrate. It is possible that this oxidising agent may have only quite a secondary effect in certain cases, especially in soils that are not rich in humus.

Resuming, we consider that the usual method of determining the sulphuric acid in soils is inadequate, and does not indicate all the sulphur present (that is, when solution is effected by nitric acid, and precipitation is carried out by barium nitrate).

It would therefore seem to be desirable that in every soil analysis the sulphuric acid should be determined by the use of hydrochloric acid for effecting solution, although it may be that the total sulphates

are not dissolved in certain cases, by reason of the strong proportion of iron and alumina.

Hence it is proposed to work according to the following procedure:—10 grms. of soil, 1 grm. of potassium nitrate, and 5 c.c. of water, are dried on the sand-bath, calcined, and then treated with 25 c.c. of hydrochloric acid. Heating is continued on the sand-bath to complete dryness, and the silica rendered insoluble. After taking up with 5 c.c. of water, and 20 c.c. of hydrochloric acid, again heat on the sand-bath for 30-45 minutes without going to dryness, filter, and wash with 100-125 c.c. of water. To the filtrate and washings add barium chloride, heat, and concentrate a little to facilitate precipitation. Finally, complete the determination in the usual manner.

THE DEPOSIT WHICH FORMS ON DILUTING MOLASSES.

By H. Pellet.

Every cane sugar factory chemist has noticed that on diluting cane molasses, and allowing it to stand for some time, a more or less copious deposit is formed. We have determined the nature and amount of this deposit in molasses from Egyptian *sucreries*, and have noticed the following:—

(1) That the quantity of the deposit varies with the molasses, which in its turn varies according to (*a*) the quality of the cane, and (*b*) the method of clarification used.

(2) That the composition of the deposit appears to be almost analogous to that of the deposit found in the evaporating apparatus, except that the proportion of silica, phosphoric acid, and impurities is different.

(3) That the quantity of deposit varies with the physical quality of the juice. That is to say, other conditions being equal, absolutely clear juice will yield a molasses containing less matter that is precipitable on dilution than the same juice not so well filtered.

Hence this deposit contains the same substances as those composing the scums, and those remaining in solution or in suspension in the juice are found in the final molasses.

During the evaporation of more or less well filtered or more or less clarified juice two phenomena take place: (1) which is quite apparent, namely, deposition in all the evaporating apparatus, different incrustations of variable composition according to the vessel of the effect being formed; and (2) the partial redissolution of matters in suspension in the syrups and after-products, as the result of their greater solubility in concentrated sugar solutions.

The impurities in suspension may be divided into two parts: those which are retained by the sugar in the centrifugal by the crystallized sugar acting as a filter, and those which pass into the centrifugal

syrup. If it is desired to determine the amount of impurities retained by the sugar, it is only necessary to dissolve 200 grms. in a litre of distilled water, and allow the liquid to settle, when after some hours a deposit will accumulate, containing both mineral and organic matter, amongst which bagasse, &c., can be easily recognised.

Further, it has been noticed that the deposit increases in proportion as the juice has been less completely clarified. We are able to state that juices *completely clarified* by an excess of lime under determined conditions give limpid molasses, which on being diluted furnish no trace of precipitate; that juices submitted to a less perfect clarification give molasses which becomes only slightly cloudy on dilution; but that juices manifestly insufficiently purified yield molasses which give on dilution a voluminous deposit.

There seems to be a definite relationship between the deposit on dilution and that obtained by a re-defecation of the molasses. This is the process we have adopted to recognize if a molasses comes from a more or less well clarified juice: 100 grms. of the molasses are diluted with 1 litre of distilled water, and a few c.c. of a solution of calcium sucrate added, when after simply heating to boiling, a more or less abundant precipitate is produced. This may be collected, washed, dried, and weighed, and the mineral matter in it determined.

On examining different molasses coming from *sucreries* clarifying the juices in different ways, it has been observed that the weight of the deposit from defecating in this way corresponds very well with the value practically attributed to the different systems of clarification.

Molasses that do not give any precipitate on dilution with water, neither give any deposit with calcium sucrate. Hence this is a means of recognizing the degree of purification of the juice.

Obviously, if sulphurous acid has been used in manufacture, the deposit obtained on dilution will contain more or less calcium sulphate and sulphite.

FURNACE ARRANGEMENT FOR FUEL OIL.

By C. R. Weymouth.

In a paper presented at the New York meeting of the American Society of Engineers, December, 1908, the writer gave various data regarding California fuel oil, air required for combustion, the various losses in oil firing, and a description of an automatic system for the regulation of boilers fired with crude oil. Although the present subject properly includes the question of air supply for combustion, the writer by reason of his former paper will here confine himself mainly to the question of furnace design, and this only for stationary water-tube boilers.

About twelve years ago the low cost and certainty of supply of crude oil led to its general use in California boiler plants. At that time, with a few notable exceptions, there were none but the crudest methods for burning oil, the owner usually employing one of the numerous improvisors of oil burners to convert his plant, the operation generally consisting in introducing a burner through the fire doors, and covering the grates with fire-brick. This plan was occasionally modified by the introduction of different forms of fire-brick arches, target walls, checker walls, &c. Many of these converted coal-burning furnaces caused frequent burning out of boiler tubes, due to the localization of heat; gave a very limited overload capacity; and by reason of various defects of furnace design, coupled with a general ignorance of the question of oil burning, produced in most instances mediocre results.

During the early period, E. H. Peabody, then testing engineer of the Babcock & Wilcox Company, began the first extensive engineering investigation of the merits of various types of furnaces, burners, &c., and after an extensive series of tests, lasting nearly two years, developed an oil furnace bearing his name, now in general use with certain types of water-tube boilers.

Mr. Peabody's tests indicated the following conclusions :—

(*a*) That while there are differences in various types of burners, these are relatively unimportant.

(*b*) The proper design of furnace is of supreme importance as determining efficiency and capacity of boilers and immunity from shutdown owing to the tube burn-outs, &c.

(*c*) Fire-brick arches and target walls are not only needless in securing high furnace efficiency, but a menace to continuity of operation, owing to the impossibility of even the best grades of fire-brick withstanding the intense heat of an oil furnace.

(*d*) Furnace depth and furnace volume are determining factors affecting furnace efficiency and capacity, and affording protection to the boiler-heating surface, particularly when the character of boiler feed water gives rise to an accumulation of scale inside boiler tubes.

(*e*) The shape of furnace and path of flame must be such as to provide a nearly uniform distribution of furnace heat over the largest possible portion of boiler-heating surface, as distinguished from an arrangement causing the direct impingement of flame on a few inches of the tube length.

(*f*) A large surface of heated fire-brick is essential to the maintenance of a high furnace temperature and complete combustion of oil.

(*g*) The air for combustion should be admitted through carefully planned openings in the floor of the furnace in such manner as to provide the most intimate contact of oil flame and in-coming air, and thus reduce the air supply to a minimum.

(*h*) The flat-flame or fish-tail burner provides for the most economical use of air for combustion.

(*i*) When all these arrangements for highest economy are observed, the furnace flame has not the bright incandescence sought by the pioneers in oil burning, but borders surprisingly on an orange red.

In the Peabody furnace the bridge wall is set back from the boiler front to give a depth of from 8 to 10 ft., depending on the size of boilers. The burner is of the back-shot type, inserted from the boiler front under the floor of the furnace and turning up at the bridge wall. It shoots the flame forward toward the front of the boiler, where there should be an extra course of fire-brick set in place without fire clay, to afford added protection to the front wall. With boilers having tubes inclined downwards from the front towards the rear, there is thus provided a furnace design of such a shape as to give the necessary increased volume as the velocity of the flame decreases in flowing away from the burner. This provides a gradual distribution of the furnace heat over the tubes the full length of the furnace, without a direct impingement of flame at any point.

Except in special boilers, the furnace should have a height at its front end of not less than 6 ft. and for large size boilers the height should be from 7 to 8 ft., depending on the character of feed water and desired overload.

Under ordinary firing, the flame should not extend into the tubes, but under forced firing it will extend part of the way through the first pass.

Under Babcock and Wilcox boilers, Mr. Peabody's record performance of 1903 was 83 per cent. efficiency at rating, based on 10 square feet of heating surface per boiler horse-power, and an overload capacity of 110 per cent. above rating.

When admitting a large excess of air and an ordinary amount of oil the flame length will be a minimum, and the temperature of incandescence will be reached at the surface of the envelope separating the vapourized oil and air for combustion. This bright flame is sought by the untrained fireman, but it results in a large loss of fuel, as the subsequent mixture of the products of combustion with the excess of air not in contact with the flame produces a lower mean furnace temperature. With economical firing the flame lengthens before coming in contact with sufficient air for complete combustion, and with the highest furnace efficiency this temperature varies from 2500° to 2800° F.

The location of the furnace relative to the boiler heat absorbing surface is of the utmost importance, not only on account of the loss of heat and consequent radiation from furnace walls when there is excessive travel, but also by reason of the large amount of heat absorbed by direct radiation as distinguished from convection. The first pass of a boiler should be located directly over the furnace,

providing the most direct transmission of the heat generated, both by convection and absorption of radiant heat.

Owing to the large area of incandescent fire-brick surface, the radiant heat is uniformly diffused over a large heating surface and the amount of heat thus absorbed becomes an important factor in determining the efficiency of boiler heating surface; for while no heat can ultimately be lost, the greater the heat in the first pass of the boiler the lower will be the temperature of gases on entering the second pass; and finally, the later passes of the boiler are able to accomplish greater cooling of the products of combustion, resulting in the lowest possible stack temperature and hence the maximum absorption efficiency of boiler.—(*Modern Sugar Planter.*)

SPAIN.

Some Notes on the Sugar Industry.

(From a British *Consular Report.*)

The cultivation of beet is very widely distributed throughout the provinces of Spain. It is produced in the south coast districts of Malaga and Almeria, where the climate is almost subtropical, in the Asturias where conditions are not unlike those of the United Kingdom, and in the regions of the central plateau with a climate which can be described as "Continental." In the hotter districts of the south the crop can only be grown by means of artificial irrigation. It is in these regions that the highest yield per acre is obtained, but in the colder districts of the centre and north-west that the percentage of sugar reaches its maximum. The yield in tons per acre on irrigated land in the various beet producing regions of Spain varies from 18 to 9 tons, with an average of almost 13 tons. On unirrigated soil the yield is from 4 to 10 tons, the average being 7 tons.

As mentioned above, the hot southern districts are the heaviest producers per acre. It has, however, been found that a constant supply of water is essential for the sugar-bearing qualities of the crop. A temporary shortage of water causes the beet to lose its leaves. The return of moisture leads to resprouting, which is said to absorb some of the sugar already formed and to interfere with the purity of the juice which becomes increasingly saline with each period of dying down and reactivity of the leaves. It is considered a general rule in Spain that the percentage of sugar obtained is in inverse proportion to the density of the crop.

The percentages of sugar obtained from crops in various regions during three consecutive years are shown below:—

District.	1907. Per cent.	1908. Per cent.	1909. Per cent.
Palencia	14·6	—	—
Alava	11·9	12·7	—
Navarre	12·3	12·7	13·7
Zaragoza	11·5	12·4	12·6
Valladolid	10·9	—	11·6
Granada	10·2	10·9	12·5

As will be seen from this table, the sugar percentage shows a tendency to increase annually. More modern methods of cultivation and a better knowledge of the use of artificial manures are responsible for the result. Nitrates and superphosphates are the fertilizers in most general use.

From the point of view of the agriculturist, the cultivation of beet is said to be profitable in Spain as long as the average price of the raw material is 22s. per ton. This, however, presupposes that the farmer can obtain land at a normal rent, which is, at the present moment, far from being the case. The price of beet has undergone very wide variations since the establishment of the industry about the year 1882. The price at Granada at that time fluctuated in the neighbourhood of 19s. per ton, and fell before 1890 as low as 16s. per ton. In the latter year the construction of seven new factories and the consequent competition caused the price to rise to £1 2s. per ton. Since then the tendency has been towards a steady rise, and the price at Granada has, owing to competition between the sugar trust and independent companies, even touched £2 14s. per ton. The present price is fairly steady at £1 10s. per ton, but, in view of the very high rents now paid for beet land, it is impossible to say what profit this represents to the cultivator. The variation in rents in the different districts is enormous and ranges between £5 12s. per acre in the Vega of Granada (the price in 1885 having been £3 4s. per acre) and £3 12s. per acre in Leon and Navarre, down to 8s. per acre in the district of Palencia.

If the position of the beet producer is a moderately satisfactory one, that of the sugar manufacturer is much less so, while that of the consumer is unsatisfactory in the extreme.

The present situation of the sugar industry is due in part to the action of an industrial combination known as the Sugar Trust and in part to the action of the Government. Up to the year 1899 home-grown sugar, while protected by a heavy import duty, was not subject to any internal taxes. In that year was imposed for the first time an excise duty of 25 pesetas per 100 kilos. (10s. per cwt.). In 1902 was formed the Sociedad General Azucarera (Sugar Trust), with the avowed object of preventing over-production and in the secret hope of being able to buy up all the existing sugar interests and of creating a monopoly. In 1907, in the hope of finding a solution to the crisis through which the industry was then passing, was passed Senor de Osma's law. It provided for the increase of the excise duty from

25 to 35 pesetas (10s. to 14s.), prohibited the establishment of new sugar factories for a period of three years and, for a further period of three years, the establishment of new factories within a radius of 50 miles of those already existing. In the Budget statement of Señor Cobian, presented to the Cortes in July, 1910, was proposed a further increase of the excise duty from 35 to 50 pesetas (20s.). The storm of protest raised by this proposal led to the reduction of the increase to 2½ pesetas (2s.), with the result that home-grown sugar is, from August of the present year, liable to a duty of 37½ pesetas per 100 kilos. (16s. per cwt.).

The following table gives the average price of beet sugar during the last eight years:—

	Price per 100 kilos. Pesetas.		Price per 100 kilos. Pesetas.
1902	100·5*	1906	99
1903	105·4	1907	105·4
1904	107·3	1908	116·8
1905	104·6	1909	117·7

The policy of the Sugar Trust has acted on the price of sugar in the same direction as the legislation of the last 12 years. It was founded with an enormously exaggerated capital, a large proportion of which was represented by factories bought up at from two to three times their real value. Quite half of these have been at various times shut down by the trust with the object of diminishing production. They have also entered into agreements with the companies which refused to join them in 1902, or have been founded since that date, for maintaining prices at the high level of the last 10 years. The total production of beet sugar from 1902-09 has been as follows:—

	Tons.		Tons.
1902..	66,151	1906	80,070
1903	93,244	1907	93,293
1904..	77,344	1908	106,426
1905	67,743	1909	84,410

The following table shows the effect on consumption of artificially raised prices and decreased production:—

	Consumption. Tons.		Consumption. Tons.
1902..	86,139	1906..	104,035
1903	94,243	1907	100,758
1904..	87,661	1908..	94,765
1905	94,766	1909	92,599

NOTE.—The above figures include the consumption of cane as well as beet sugar.

The annual consumption per head of population is reckoned at 4·9 kilos. (10·78 lbs.), or roughly half what it should be under normal

* Or say 40s. 6d. per cwt.

conditions. The increase of consumption during the period 1900-8 has been insignificant and now tends to become an annual decrease.

In March, 1911, the situation, as described above, became considerably modified by the breaking of the convention between manufacturers by which high prices have been maintained. As a result of this rupture, the price of sugar fell by 20 pesetas per 100 kilos. It is natural to suppose that an increase of consumption will take place, but the increase can hardly be sufficiently rapid to compensate manufacturers for the fall in price. The profit to producers per 100 kilos. at the prices of 1909-1910 is reckoned at roughly 40 pesetas. To make up for the loss of 20 pesetas in the price consumption would have to be doubled. That any such increase in consumption will take place is most improbable, nor do manufacturers possess the means of increasing their output to keep pace with any such demand. It can only be assumed that the profits of such companies as the trust (capital over £5,000,000), which last year paid 3 per cent., will dwindle down to nothing. Such companies as can still work at a profit will increase their production in the hope of compensating themselves for the loss in price and, unless the improbable happens and a corresponding increase of consumption takes place, there will remain the same exaggerated amount of stock in the hands of the manufacturers and consequent "tying up" of capital, as was for many years a regular phenomenon of the Spanish sugar industry.

So much Spanish capital is invested in sugar that the attention of the Press and of the public is more frequently turned to that industry than to any other in the Peninsular. The projects brought forward with a view to improve the position either of the agriculturist, the producer of sugar, or the consumer are innumerable. From one point of view only—that of the Treasury—is the present system satisfactory. The sums collected during the last ten years under the heading of sugar excise have been as follows:—

	Pesetas.		Pesetas.
1900	12,541,000	1906	26,168,000
1901	19,332,000	1907	26,696,000
1902	21,680,000	1908	32,358,000
1903	23,376,000	1909	33,763,000
1904	22,658,000	1910	38,893,000
1905	23,564,000		

It is certain that the extension of beet cultivation would lead to an increase in the areas under other crops; subsidiary products of the industry, such as cattle foods, would be available for the stock raiser, and allied industries in sweets and alcohol would be established. The temporary loss to the Treasury would, probably, soon be made good by increased receipts under other headings.

PUBLICATIONS RECEIVED.

Sugar Cane in Porto Rico. By D. W. May. Bulletin No. 9; Porto Rico Agricultural Experiment Station. U.S. Dept. Agric., Washington, 1910.

Mr. May, who is special agent in charge at the Porto Rico Experiment Station, has written an interesting report, from which it is apparent that some very valuable work is being done in improving the position of the sugar industry of that colony.

In the direction of increasing the production by improved varieties, a series of experiments have been made at the station, and at some of the larger estates. A number of seedling canes from Barbados, Demerara, and Trinidad have been under trial, and cuttings from these were sent to planters throughout the island, and were very favourably received, having proved superior to the old varieties, not only in increased production, but also in hardiness and freedom from disease. New varieties of cane from seed are also being grown, but so far sufficient time has not elapsed to test them as sugar producers.

In Porto Rico the method of draining in vogue is somewhat primitive and wasteful, and it was decided to experiment with tile drains placed underneath the surface, as being the most suitable under the circumstances. It was found too costly to import tile from the States, but a machine was purchased for $300 for making them on the spot. This was found to be very efficient, and not only have the low lands of the station farms been drained in this way, but a large number of tiles has been sold to planters, who are now realizing the value of the new system.

As regards irrigation, there is great room for improvement, for the presence of too much water on one side of the island, and too little on the other, is quite apparent. Three million dollars have been set aside by the Legislature for the purpose of establishing plants on the south side of the island, and these should do much good. Many private irrigation enterprises are already in operation, and the average cost of working these, by electric and gasoline pumps, by gas and wind, and by gravity through canals, is computed to be from $2·10 to $6·05 per acre.

Although the cane lands of Porto Rico have been under cultivation for many years, during all this time ploughing has only skimmed the surface of the soil, so that considerable improvement can be effected in this direction. The ordinary mould board plough gave the best results on heavy clay lands, but the disk plough has not proven effective.

Coming to the question of planting, it is pointed out that as the labour in Porto Rico is becoming scarcer and wages are increasing it is necessary to employ some method with machinery to lessen the cost of the present system. As regards seed planting, experiments

showed that with the Porto Rican method, that is putting the seed in holes, Otaheite can give a yield of 49·76, and Cristallina 60·56 tons per acre; while by the Hawaiian system in continuous furrows the Otaheite gave 50·36 and the Cristallina 71·48 tons per acre, a difference of 0 6 and 10·92 tons per acre respectively in favour of the Hawaiian procedure.

Respecting fertilization, numerous experiments have been made with the object of determining the requirements of the soils in different parts of the island. It was demonstrated that all the soils are more or less in need of all three elements—nitrogen, phosphorus, and potash—and are also benefitted by an application of burnt lime.

Porto Rican canes are comparatively healthy for an old cane growing country; nevertheless, there are enough of both insect and fungus diseases to cause large losses. Mr. May concludes his valuable bulletin by emphasizing the importance of preventative measures, and by indicating the lines along which his investigations on the treatment of cane diseases will be directed in the future.

ÉTUDE SUR LES LEGUMINEUSES. By P. de Sornay, Assistant Director of the Station Agronomique, Mauritius. Bulletin, No. 24, of the Station Agronomique. Published at the Storekeeper-General's Printing Establishment, Mauritius. 1910.

It is now generally known that the *Leguminosae* play a special part in agriculture, and each year their importance is being more and more recognised. M. de Sornay, a valued contributor to this *Journal*, has compiled a bulletin, which is in fact a very complete text book on the subject, and without doubt will be found of considerable value to all concerned in agriculture. The first portion of the "Study" is devoted to a discussion of the numerous theories and controversies which have arisen out of the question of the absorption of the nitrogen of the air by leguminous plants. The important work of Hellriegel and Wilfarth receives special attention; while M. de Sornay does not omit Jamieson's theory of the function of root nodules, so persistently held, although surely quite at variance with the facts demonstrated by the most eminent investigators. The mechanism of the assimilation of gaseous nitrogen, the various bacteria of leguminous plants, and the artificial inoculation of soils are also adequately dealt with under this heading. Other sections of the bulletin discuss the practical value of legumes. Numerous analyses have been made of the different peas cultivated in Mauritius, and these figures will be found of value to all agricultural chemists. Of especial practical importance is the chapter on the *Leguminosae* as applied to cattle feeding, in which complete data of the different local fodders are summarized in tables. Finally, the study is completed by a discussion of the various diseases and pests which affect the order of plants under consideration.

ABSTRACTS, SCIENTIFIC AND TECHNICAL.*

New Method of Clarifying Cane Juices. *Anon. Amer. S. Ind. B. S. Gaz., 1911, 13, 363.*

Recently some experiments have been carried out in Hawaii on a new method of clarifying cane juice with apparently very successful results. It is the invention of Ernest W. Kopke, and the statement is made that juice more perfectly clarified than by means of settling tanks, filter presses, or sand filters, can be obtained within a few seconds of leaving the heater. At the present time in all Hawaiian mills the juice is clarified in the ordinary manner, that is, after treatment with lime it is run into settling tanks to separate the insoluble matter by subsidence, which process occupies at least two hours. According, however, to the Kopke method, the juice from the mixing tank goes directly into a centrifugal, which removes the insoluble matter in a few minutes, the clear spun-out juice then passing to the effect supply tanks. During the past season at Honolulu Plantation the Kopke machine has been in operation, and several hundred practical tests have been made, each demonstrating that the apparatus is commercially practical. As advantages, in addition to the ease with which clear liquors may be obtained, the following claims are made: (1) The mud and scums may be washed in the machine practically free from sugar, with a minimum amount of water. (2) Economy in fuel is effected, since the amount of water required is less than with settling tanks, filter presses, or sand filters. (3) Cost of labour is saved, for the number of hands required to operate the centrifugals is at least 30 per cent. less than that demanded for settling tanks. (4) The space occupied by the new apparatus is small compared with that demanded for the settling tank system, and the installation does not require any change in the general arrangement of the factory. (5) Clarification as ordinarily carried out is difficult of supervision, and scarcely permits of scientific control, whereas the efficiency of the new system may be maintained with the minimum amount of trouble. It is lastly stated that "the apparatus, equipment, and processes found in practice to be the most suitable have been thoroughly covered by patent applications; and, while it is known that others have worked along the same line, the practical progress made during the past year at Honolulu Plantation, and the success obtained at all points, is far in advance of anything hitherto accomplished. No important changes in the machine are anticipated at present, but it will be some months before the inventor will be in the position to put it on the market."

Preparation of the Lime in the Cane Sugar Factory. *By F. E. Coombs. La. Planter, 1911, 47, 101-102.*

Adding the lime used for defecation in the form of powder is more or less unsatisfactory on account of the fact that any given weight or measure of the material differs from the next portion used, owing to the varying amount of sand and stone, of moisture, and of carbonate. It often happens that when working from a pile of powdered lime sudden changes in the amount necessary for defecation are observed without any chemical alteration in the juice taking place to account for this. Investigation will then show that the cause was simply the caving in of the top part of the pile upon the place from which the lime had been scooped, the top part having been the most exposed to air, and having consequently become quite different in composition from the material in the protected middle portion of the lot. It is thus seen that any process dependent upon the use of either weighed or measured lime powder is liable to cause some trouble, it being impossible off hand to judge the quality of the lime in respect of moisture and carbonate, the amount of which is constantly increasing in different parts of the heap. When milk-of-lime is used it is customary to stir in the whole of the lime with the whole of the water, keep the mixture agitated, and measure it into the juice. So long as any one batch of the mixture is in use, a better result than from the use of small amounts of powdered lime will be obtained, Nevertheless, there will be differences between successive lots, on account of the irregularity in the composition of the rough lime from which it is made. Moreover, when the lime is slaked separately for every batch, and the batches are small, there is a great possibility of hurried and imperfect slaking, which produces a mixture that changes in tempering value after having been made a few hours. From this the conclusion is to be drawn that the best method of preparation is to slake in large quantities, so that any one lot lasts long enough to ensure complete slaking. When this is done, and the material is in large mass, there is no action of the air upon the lime after the first film over the surface is once formed. In the case of a sugar house using 1 to 10 tons of quick-lime weekly much economy could be effected by treating it on a large scale, and with a properly arranged installation it is feasible to eliminate all the disadvantages adherent to the present mode of working. In this article a plant is described for automatically tempering 300,000 gallons of milk-of-lime daily in such a way that a liquid of constant quality is ensured, with a minimum of waste, and entire freedom from grit and stone. Close to the railroad siding there is erected a reinforced concrete foundation, comprising an ample storage for the rough, unslaked material, two shallow slaking vats, and two horizontal cylindrical circulation chambers, provided with shafting for a stirring paddle, these chambers being of sufficient capacity to hold milk for 24 hours. Above the circulation chambers

a vertical engine is placed for driving the stirrer, for conveying the rough lime from the railway trucks into the store, and for operating the centrifugal pump for sending the milk to the tempering and settling tanks. It is proposed to slake the lime in such a form that it will stand alone, without being too stiff to cut with a small jet of water from a hose. A definite number of square feet of the thick slaked mass would be marked off for each batch, and this amount cut off and thinned by the jet of water, after which the milk would go to the circulation chambers *viâ* a strainer, being finally brought to 16° Bé. or any convenient density.

ALUMINIUM BISULPHITE AS DECOLORIZING AND DEINCRUSTATING AGENT. *By O. Durieux. Sucr. Belge, 1911, 35, 535-536.*

Bisulphite of alumina is a compound of sulphurous acid and alumina, and has the formula $Al(HSO_3)_3$. It has considerable decolorizing power, which depends upon (1) the reducing action of the sulphurous acid, and (2) upon the property the alumina possesses of absorbing the organic colouring bodies from the juice. Further, the gelatinous precipitate that is produced by the use of this body hinders incrustation on the tubes of the evaporating apparatus, so that the proposed new clarifying agent is a deincrustating material as well as a decolorizer. When using it, the second carbonatation juice, saturated to neutrality, is filtered, and to the clear juice the aluminium bisulphite is added at the rate of 300 c.c. for every 10 hectolitres, after which the treated juice is filled into the multiple effect supply tanks. On adding the bisulphite to the juice in this way it is immediately hydrolyzed according to the following equation:—

$$2Al(HSO_3)_3 + 6HOH = Al_2(OH)_6 + 6H_2O + 6SO_2,$$

and the sulphurous acid destroys a portion of the organic colouring bodies, while the alumina unites with the lime in solution to form calcium aluminate, an insoluble gelatinous body. In the multiple effect (so it is stated) this gelatinous precipitate causes the copious formation of bubbles, and in this way prevents the adherence of mineral matter to the calorizator tubes, so that it is unnecessary to clean the apparatus throughout the entire campaign. On taking off the syrup from the last vessel of the effect at 27-30° Bé., it is passed through a Danêk filter in which the gelatinous precipitate of calcium aluminate is retained, and the syrup in passing through this precipitate undergoes further decolorization. In this way it is claimed syrup is freed from almost all its impurities. Alkali salts in the form of potassium sucrate $C_{12}H_{21}O_{11}K$ and additional compounds of the nature of $C_{12}H_{22}O_{11} . 2NaCl$ are entirely eliminated, and consequently crystallization during malaxage proceeds easily. Aluminium bisulphite has been used by the author during the past three campaigns with great success.*

* Aluminium bisulphite was used many years ago by both Kessler and Massé as a clarifying and decolorizing agent, and in some respects the results obtained were satisfactory.—(ED. *I.S.J.*)

Solubility of Lime in Sugar Solutions. *By H. Claassen. Zeitschrift, 1911, 489-509.*

Although a great amount of work has been done on the important question of the solubility of lime in sugar solutions, it is open to criticism on the grounds that the various results obtained are not in agreement; that the experiments have not been carried out with sufficient accuracy; and that, moreover, the conditions chosen do not represent those obtaining in practice. Bearing in mind these shortcomings, Dr. Claassen has carried out a very careful series of investigations, described in detail in this article, as the result of which he comes to the following conclusions:—(1) *Effect of the way in which the lime is added.*—The greatest amount of lime is dissolved when the addition is made in the form of dry powder, and least when milk-of-lime, which has been prepared for some t.me, is employed; while the solubility of calcium hydroxide and freshly prepared milk-of-lime lies intermediate between these two. (2) *Influence of the kind of lime.*—No appreciable difference between ordinary lime made from lime-stone, and that prepared from marble, can be detected. (3) *Effect of the amount.*—Up to a lime content of 2·0 to 2·5 per cent. the solubility of the lime rises, and from this point increased amounts do not raise the solubility, but rather appear to diminish it a little. (4) *Influence of temperature, and duration of stirring.*—With increase of temperature the solubility decreases. At temperatures below 50°C. the lime dissolves very slowly, so that the amount dissolved increases in proportion to the duration of stirring; but above 70°C. the maximum amount of lime dissolves in five minutes after the addition is made. (5) *Influence of the sugar content of the solution.*—With increase of sugar content the solubility of the lime increases, this increase being approximately the same at all temperatures. (6) *Behaviour of sugar solutions saturated with lime at low temperatures on being heated.*—If sugar solutions saturated with lime at temperatures from 0 to 50°C. be heated with excess of lime, some of the lime in solution is precipitated, not as calcium sucrate, as might be supposed, but as lime. (7) *Behaviour of sugar solutions saturated with lime at high temperatures on being cooled.*—Sucrose solutions saturated with lime at high temperatures dissolve more lime when cooled in the presence of excess of lime. (8) *Solubility of lime in impure sugar solutions.*—Impure sugar solutions behave towards lime in the same way as pure sucrose solutions of the same sugar content. Dr. Claassen then points out that for practical working the following points are of importance: (*a*) In defecation, after the addition of the lime, sugar is neither precipitated by heating nor by cooling. (*b*) Since the sugar content of the juices varies but little, and the amount of lime used makes scarcely any difference, the quantity of lime dissolved in the juices depends almost entirely on the manner in which the lime is added (*i.e.*, whether as dry powder or as milk), and on the temperature which is used.

On the Causes of the Occurrence of Traces of Arsenic in Raw Sugars. *By A. Herzfeld and A. E. Lange. Zeitschrift, 1911, 365–375.*

Some months ago an objection was raised against a consignment of German raw sugar by a British firm of refiners, who maintained that it contained not inconsiderable traces of arsenic. On taking up the question, the authors were able to confirm the statement of the British refiners as to the comparatively high trace of arsenic in this batch of raw sugar; and they forthwith commenced an investigation into the cause of the occurrence of this impurity. First of all, samples of raw sugar from the same factory in which the contaminated consignment had been made during the previous campaign, as well as samples from other German factories, were carefully examined, but in both cases with negative results. It was, therefore, concluded that the presence of the arsenic could not have occurred in the ordinary way of working, but was accidental. Samples of the sulphur used were tested, and found to be arsenic free; and although the coal was found to contain arsenic this did not solve the question, since the amount found was not above the average. Finally, the authors came to the conclusion that the presence of the comparatively high trace of arsenic in the raw sugar was in all probability to be attributed to the insufficient washing of the carbonic acid gas used in its manufacture, in consequence of which the volatile arsenic from the coal and limestone in the kiln had not been condensed in the scrubber, but had found its way into the juices.

In connection with this matter, the authors recall the unfortunate epidemic occasioned by the arsenical contamination of beer, which occurred in England in 1900-01, as the result of which the amount of arsenic in all food and drinks is now carefully controlled by law in this country, and restricted to a very minute amount. They quote from the blue book containing the Reports of the Royal Commission of Arsenical Poisoning,* giving the opinions of various experts as to the most probable sources of the presence of arsenic in both beet and cane sugars. It appears that for cane sugars these sources may be: the defecation lime, the phosphoric acid, and, in the case of Demerara sugars, the stannous chloride. In general, the arsenic in West Indian sugars was found to be quite low, as the following figures, quoted by the authors from the blue book, show:

No. of sample.	Designation of sample.	As_4O_6 in grains per pound.	As_4O_6 in parts per million.
15	Demerara sugar No. 1. Common Demerara (London Retailer A) bought 14th October, 1902	free	—
16	No. 2. Best Demerara (London Retailer A) bought 14th October, 1902	$\frac{1}{600}$	0·23

* This volume, published by Eyre & Spottiswoode, Fleet Street, London, may be regarded as a text-book on the subject.—(Ed. *I.S.J.*)

No. of sample.	Designation of sample.	As_4O_6 in grains per pound.	As_4O_6 in parts per million.
17	No. 3. Raw Brown moist sugar (London Retailer A) bought 14th October, 1902	free	—
18	Demerara (London Retailer A) bought 11th October, 1902	free	—
19	Raw Brown Demerara (Retailer C) bought 11th October, 1902	$\frac{1}{1000}$	0·15
20	Best Demerara (Retailer C) bought 11th October, 1902	traces	—
21	Demerara (Retailer D) bought 11th October, 1902	free	—
22	Demerara (Retailer E) bought 11th October, 1902	$\frac{1}{750}$	0·19
23	Demerara (Retailer F) bought 11th October, 1902	$\frac{1}{400}$	0·35

ON THE QUESTION OF THE OCCURRENCE OF RAFFINOSE IN CANE PRODUCTS. *By H. Pellet. Österr.-Ungar. Zeitsch., 1911, 39, 942-948.*

Strohmer, in a recent interesting paper on the presence and determination of raffinose in raw sugars (*Österr.-Ungar. Zeitsch., 1910, 38, 649-666*), gave the results of his examination of raw cane sugars, summarizing them in the following table:—

No.	Source.	Invert Sugar Content.	Direct Polarization after Clarification with Neutral Lead Acetate. *a*	Clerget Sugar, by Herzfeld's original Method. *b*	Difference. *a—b*	Clerget Sugar, by Inversion after clarifying with Neutral Lead Acetate. *c*	Difference. *a—c*	Sugar Content by Wortmann's Formula. *d*	Difference. *a—d*	Raffinose by Wortmann's Formula.
1	Java	0·15	94·90	94·56	+ 0·34	—	—	—	—	—
2	Demerara ..	0·08	97·05	96·68	+ 0·37	—	—	—	—	—
3	Cuba	0·51	96·70	96·61	+ 0·09	—	—	96·58	+ 0·12	0·15
4	Demerara ..	0·95	97·48	—	—	97·38	+ 0·10	97·10	+ 0·38	0·37
5	Java	0·43	98·97	—	—	99·03	— 0·06	98·93	+ 0·04	0·09
6	Porto Rico..	1·21	95·11	—	—	95·36	— 0·25	95·25	— 0·14	0·13

From these determinations it was concluded that "the above figures clearly afford no proof of the presence of raffinose in raw cane sugars..." In now commenting upon these results, Pellet, nevertheless, points out

that in the case of colonial products, when small amounts of reducing sugars are present, the figure for the sucrose by the double polarization method should be higher and not lower than the direct polarization (compare cols. *a* and *b*). He explains that if the product contains a small amount of reducing sugars, in which a high proportion of dextrose is present, the sucrose by double polarization may be about the same as the direct polarization, but should not be appreciably less. If, on the contrary, the product contains a fairly large amount of reducing sugars, the sucrose by double polarization will almost invariably be higher than the direct polarization. Although the author has examined a very great number of cane sugars, so far he has never met with any in which the sucrose by double polarization is less than the direct polarization, an experience which is corroborated by analyses published by C. A. Browne (*Zeitschrift*, 1909, 408), who in the case of raw cane sugars always found the sucrose by double polarization to be higher than the direct polarization by 0·8 to 3·9 per cent. Attention is also called to the author's own recent paper (this *Jl.*, 1910, 328-335) which gives the results of analyses of raw sugars, in all of which except one the sucrose by double polarization is higher than the direct polarization. In explanation of Strohmer's results, the author suggests that the inversion polarization may have been effected on the unclarified solution, which procedure is in use in the Institut für Zuckerindustrie in Berlin. If this were so, then a source of error would be introduced, for although in the case of beet sugars it may be accepted that no pectin substances are present to affect the accuracy of the determination, with cane sugars this is not so. If the sugar solution be not defecated for analysis, either with basic or neutral lead acetate, these pectin substances are not removed, but remain to decrease the inversion polarization in consequence of their very high dextro-rotation.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E. Chartered Patent Agent, 6, Lord Street, Liverpool; 77, Market Street, Bradford; and 285, High Holborn, London.

ENGLISH.—Applications.

16823. G. C. Dymond. (Communicated by A. Huillard, France.) *Process for making sugary fodder.* (Complete specification.) 22nd July, 1911.

17031. M. A. Adam. *Reduction of hydrogenization of sugars.* 25th July, 1911.

17221. A. T. Cocking and Kynoch, Ltd. *Nitration of sugars.* 27th July, 1911.

GERMAN.—Abridgments.

235909. August Knüppel, of Cöthen, Anhalt. *A device for catching the leaves of beetroot, straw, and the like in washing troughs.* 11th September, 1910. A continuous rail track is arranged above the washing trough and is provided with a rise and fall, on which track displacement rakes are suspended on rollers travelling on the track and are moved forward by means of a drawing chain in such a way that the rakes are alternately immersed in the washing trough and again withdrawn therefrom, the leaves and the like caught by the rakes being removed therefrom when the latter are in their highest position, by a revolving spiked roller which engages the rakes.

236535. Fritz Wellensiek, of Hanover. (Patent of Addition to Patent No. 226430, of 28th June, 1908.) The process described in the principal Patent No. 226430 is employed for the clarification and purification of sugar juice. 10th November, 1908.

236841. Stefan von Grabski, of Kruschwitz, Posen. *A centrifugal having a conveyor worm arranged co-axially in the drum.* 31st August, 1909. This centrifugal has, in addition to the co-axially arranged conveyor worm, an arrangement for introducing a fluid medium, for instance for casing sugar and so forth, and is characterized by the provision of conical sheet metal shells overlapping one another to which the medium employed for casing or other like purposes (such as water, casing cleare, syrup or the like) is supplied, and from which it falls in drops through suitable slots in the conveyor worm or helical drum on to the material contained between the sieve casing and the drum, and there acts on the substance. A further improvement consists in plates being arranged irregularly displaced between the feed jacket for the casing medium and the straining jacket, in order to divide the casing medium introduced and to cause it to act on the material treated in the form of spray.

UNITED KINGDOM.

IMPORTS AND EXPORTS OF SUGAR
To End of August, 1910 and 1911.

IMPORTS.

Unrefined Sugars.	1910. Tons.*	1911. Tons.*	1910. £	1911. £
Russia	93	1,404	1,190	15,945
Germany	97,296	377,338	1,310,308	4,043,960
Netherlands	7,696	6,102	92,543	69,301
Belgium	3,247	14,134	40,073	164,793
France	430	244	6,260	2,366
Austria-Hungary	41,172	40,421	548,618	408,103
Java	34,698	30,319	516,044	436,223
Philippine Islands	....	....	....	....
Cuba	96,335	3,861	1,371,613	29,610
Dutch Guiana	4,654	4,755	67,752	59,508
Hayti and San Domingo	75,555	27,323	1,064,503	296,002
Mexico	10,519	6,907	149,453	81,654
Peru	38,366	19,058	510,632	181,433
Brazil	49,414	12,167	598,157	107,804
Mauritius	38,171	34,781	557,114	350,889
British India	8,871	1,743	96,674	14,389
Straits Settlements	792	224	9,389	2,094
Br. West Indian Islands, Br.Guiana & Br.Honduras	67,689	49,120	996,188	658,112
Other Countries	20,244	12,548	272,455	125,508
Total Raw Sugars	595,241	642,450	8,208,966	7,047,694
Refined Sugars.				
Russia	94	59,978	1,452	759,259
Germany	235,197	295,612	3,735,678	3,982,552
Holland	58,026	87,055	970,120	1,238,852
Belgium	19,750	30,450	343,740	445,005
France	57,842	4,155	959,790	61,602
Austria-Hungary	137,540	148,909	2,268,146	2,029,693
Other Countries	66,250	7,165	2,137,995	101,428
Total Refined Sugars	574,700	633,325	9,416,921	8,654,391
Molasses	107,563	86,369	488,979	353,415
Total Imports	1,277,504	1,362,144	18,114,866	16,055,500

EXPORTS.

British Refined Sugars.	Tons.	Tons.	£	£
Denmark	2,637	3,257	38,457	39,125
Netherlands	2,111	1,897	32,558	25,551
Portugal, Azores, & Madeira	926	713	13,731	8,258
Italy	155	943	2,181	11,104
Canada	6,005	6,053	97,619	88,582
Other Countries	5,752	7,306	106,693	113,710
	17,586	20,170	291,239	286,330
Foreign & Colonial Sugars				
Refined and Candy	502	893	9,614	13,216
Unrefined	3,163	5,088	45,313	60,043
Various Mixed in Bond	75	....	1,285	....
Molasses	251	272	1,825	1,775
Total Exports	21,577	26,423	349,276	361,364

* Calculated to the nearest ton.

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1911. Tons.		1910. Tons.
Total Receipts Jan. 1st to Aug. 24th..	1,627,910	..	1,757,157
Receipts of Refined ,, ,, ...	231	..	149
Deliveries ,, ,, ...	1,620,947	..	1,688,604
Importers' Stocks, August 23rd	6,963	..	71,903
Total Stocks, September 6th	157,000	..	287,650
Stocks in Cuba, ,, ...	14,000	..	78,000
	1910.		1909.
Total Consumption for twelve months ..	3,350,355	..	3,257,660

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR FOR 1909, 1910 AND 1911.

(Tons of 2,240 lbs.)	1909. Tons.		1910. Tons.		1911. Tons.
Exports	1,244,983	..	1,495,533	..	1,283,351
Stocks	155,449	..	205,525	..	115,235
	1,400,432	..	1,701,058	..	1,398,586
Local Consumption (7 months)..	36,810	..	38,152	..	42,530
	1,437,242	..	1,739,210	..	1,441,116
Stock on 1st January (old crop)..	....	..	....	..	....
Receipts at Ports up to July 31st	1,437,242		1,739,210		1,441,116

Havana, 31st July, 1911. J. GUMA.—F. MEJER.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION OF SUGAR FOR EIGHT MONTHS ENDING AUGUST 31ST, 1909, 1910, 1911.

	IMPORTS.			EXPORTS (Foreign).		
	1909. Tons.	1910. Tons.	1911. Tons.	1909. Tons.	1910. Tons.	1911. Tons.
Refined	659,894	574,700	633,325	568	501	893
Raw	525,479	595,241	642,450	2,574	3,238	5,088
Molasses	116,878	107,563	86,369	189	251	272
	1,302,251	1,277,504	1,362,144	3,331	3,990	6,253

	HOME CONSUMPTION.				
	1909. Tons.		1910. Tons.		1911. Tons.
Refined	650,702	..	552,488	..	627,135
Refined (in Bond) in the United Kingdom........	397,245	..	416,237	..	439,405
Raw	82,117	..	102,424	..	84,962
Molasses	90,267	..	94,787	..	85,281
Molasses, manufactured (in Bond) in U.K........	46,681	..	44,732	..	50,602
Total........................	1,267,012	..	1,210,668	..	1,287,385
Less Exports of British Refined..................	21,281	..	17,586	..	20,170
	1,245,731		1,193,082		1,267,215

Stocks of Sugar in Europe at uneven dates, August 1st to September 2nd, compared with previous Years.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	Total 1911.
161,300	427,470	172,620	206,500	103,940	1,071,830

	1910.	1909.	1908.	1907.
Totals	979,330	1,081,200	1,068,910	1,243,580.

Twelve Months' Consumption of Sugar in Europe for Three Years, ending July 31st, in thousands of tons.

(Licht's Circular.)

Great Britain.	Germany.	France.	Austria-Hungary	Holland, Belgium, &c.	Total 1910-11.	Total 1909-10.	Total 1908-09.
1967	1363	774	660	248	5013	4731	4622

Estimated Crop of BEETROOT SUGAR on the Continent of Europe for the current Campaign, compared with the actual crop of the three previous Campaigns.

(From Licht's Monthly Circular.)

	1910-1911. Tons.	1909-1910. Tons.	1908-1909. Tons.	1907-1908. Tons.
Germany	2,602,000	2,033,834	2,082,848	2,129,597
Austria	1,535,000	1,256,751	1,398,588	1,424,657
France	725,000	806,405	807,059	727,712
Russia	2,140,000	1,126,853	1,257,387	1,410,000
Belgium	285,000	249,612	258,339	232,352
Holland	223,000	198,456	214,344	175,184
Other Countries .	590,000	465,000	525,300	462,772
	8,100,000	6,136,911	6,543,865	6,562,274

1. Dr. Mrazsek (London); 2. Mr. Main (London); 3. Dr. Wilhelmj (Berlin); 4. Dr. Wendel (Magdeburg); 5. Prof. Andrlik (Prague); 6. Herr P. Oppermann (Berlin); 7. Mr. H. Eynon (London); 8. Dr. A. E. Lange (Berlin); 9. Mr. Peden (Greenock); 10. Herr O. Schrefeld (Berlin); 11. Mr. Fermann (Amsterdam); 12. Dr. C[illegible] [illegible]deburg); 13. Herr A. Schneider (Berlin); 14. M. H. Pellet (Paris); 15. Herr W. Rosenkranz (Berlin); 16. Dr. Gabel (Magdeburg); 17. [illegible]ock); 18. Herr Strohmer (Vienna); 19. Mr. L. J. de Whalley (London), President on the first day; [illegible] Saillard (Paris); 21. Prof. Dr. Herzfeld (Berlin).

THE

INTERNATIONAL

SUGAR JOURNAL.

No. 154. OCTOBER, 1911. VOL. XIII.

☞ All communications to be addressed to the Editor, Office of "The Sugar Cane," Altrincham, near Manchester. All Advertisements to be sent direct.

☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

Cheques and Postal Orders to be made payable to NORMAN RODGER, Altrincham.

The Editor will be glad to consider any MSS. sent to him for insertion in this Journal and will endeavour to return the same if unsuitable; but he cannot undertake to be responsible for them unless a stamped addressed envelope is enclosed.

NOTES AND COMMENTS.

The Raffinose Conference.

Facing this page will be found a photograph of the delegates who took part in the Raffinose Conference, held in Berlin some months ago. It will be remembered that the Conference was initiated by the Sugar Association of London with the object of discussing the raffinose question, since many raw beet sugars sold to British firms were found to contain considerable amounts of this trisaccharide. The photographic group is a most interesting one, containing as it does most of the leading sugar chemists. We are much obliged to Prof. Dr. Herzfeld, Director of the "Institut für Zuckerindustrie in Berlin," for enabling us to publish it.

A Centrifugal Clarifying Process.

Mr. E. W. Kopke, of Honolulu, has lately patented a new centrifugal clarifier which, to judge from the preliminary trial accorded it, has a considerable future before it, and must make its mark in the sugar world. As is well known the usual practice in cane sugar mills is for the juice, after being treated with lime and other clarifying matter, to be run into settling tanks, where the insoluble constituents are removed by precipitation, the process occupying some hours. By the new Kopke process, the juice is run direct from the mixing tank

into a centrifugal, which removes the insoluble matter within a few seconds and passes on to the boiling tanks a clearer juice than is possible by the settling process.

It is claimed that all the juice extracted from the cane can be more perfectly clarified than is possible by any other process at present in use, and that in a period of less than one minute. As the older processes require over two hours to operate, the new system offers a great saving as regards length of time. There is, moreover, a saving in labour, and there is also an elimination of the "rule-of-thumb" skill required to decide when clarification is complete, as the machine does its work automatically. It is calculated that four machines would clarify all the juice from a 1000-ton a day factory. The labour required is indeed put at 30 per cent. of that needed for the older system as no filtering medium is used, and the space occupied by the new apparatus is less than that covered by the settling tanks. The inventor states that the mud and scums, accumulated in the centrifugal machines or separated from the juice, may be washed practically free of any sugar contents and with a minimum of water. In other words there need be no sugar lost in the mud, and as little water need be used to save it. As whatever water may be used must be later evaporated at the expense of fuel, it is of course desirable that no more be used than is necessary; but the amount of water used in washing in the centrifugal is less than by any method now in use. We presume the Honolulu Ironworks will eventually take up the manufacture of this centrifugal, but we understand it will be some months ere the inventor is able to place his apparatus on the market.

Barbados and Central Factories.

A comprehensive scheme for the erection of central sugar factories in Barbados on a co-operative basis has unfortunately received a serious check at the hands of the Legislature in that island. The Bill to give effect to the scheme has been before the latter the greater part af the recent session, and has in the end been abandoned because the Upper House insisted on the insertion of a simple amendment which in no way affected the principle of the Bill, while the Lower House refused to accept it. The House of Assembly proposed that an advertisement in the *Official Gazette* should be deemed sufficient notice of the intention of an estates owner to join a group to erect a central factory; but the Legislative Council (the Upper House) considered that the interests of mortgagees needed safeguarding, and so stipulated that the assent in writing of mortgagees and lien holders must first be obtained. The two Houses quarrelled over this small matter, and not being able to agree, the labours of three months were wasted. To kill the Bill on such a feeble pretext suggests that its supporters had lost some of their original enthusiasm for the expediency of the measure. For why otherwise should the Lower

House attach such importance to a minor amendment? Indeed, the explanation generally accepted in Barbados is that the promotors were glad of an excuse to drop the Bill, having come to feel, as the *Argosy* points out, "that in actual practice the results might work out differently from what they did in theory. The untoward fate of the measure is another illustration of the strong conservatism of the Barbados planting community, who cling to methods of manufacture long since archaic with a tenacity that is remarkable. Only the splendid cultivation that the planters give to their crops, and the peculiar adaptability of the soil of Barbados to the growth of sugar cane have prevented the industry from becoming extinct in the island. It would be idle, however, to think that the present conditions can continue indefinitely. The market for muscovado and molasses is becoming increasingly circumscribed, and sooner or later the estate owners must give their serious attention to the introduction of up-to-date factory equipment."

The Case of Dr. Wiley.

According to a Washington correspondent of *The Times*, the American President, Mr. Taft, is at present faced with three serious problems, the solution of which is bound either to enhance or mar his presidential reputation. One of these is the case of Dr. Wiley, well known to our readers as a chemist of international reputation in matters relating to sugar. Dr. Wiley has been for some time the Head of the Bureau of Chemistry attached to the Department of Agriculture, Washington, and in that capacity has had the task of carrying into effect the Pure Food Law and has therefore had to wage a strenuous war against all who adulterate and misbrand. A trivial matter—the alleged appointment of a minor official without due authority of law—led to the investigations of a Committee who recommended that Dr. Wiley and his associates be requested to resign; and this decision of theirs was endorsed by the Attorney-General who declared the culprits worthy of "condign punishment." Thereupon the cry was raised that this was a plot on the part of the food and drug manufacturers of the less reputable kind to overthrow their enemy. To quote *The Times*, "a Democratic Congressional Committee, hungry for revelations that might injure a Republican Administration, soon got to work. It was very quickly apparent that all was not well in the Department of Agriculture, and that Dr. Wiley had enemies within as well as without. The case was carried to the President, and the President is faced with a dilemma. Either he must sacrifice Dr. Wiley, and therewith raise a storm of protest about his head; or he must uphold Dr. Wiley and overhaul the Department, thus administering an indirect rebuke to the Secretary of Agriculture (who seems to have little sympathy with his subordinate), and a direct rebuke to the Attorney-General, who is said to have condemned

Dr. Wiley's conduct so sweepingly. Neither alternative is welcome on the eve of a Presidential election."

Those who view Dr. Wiley's work from a non-political standpoint and thoroughly approve of his vigorous campaign in the cause of pure food will wish the eminent scientist a triumphant exit from beneath the political cloud under which he has recently been placed. He is surely too good a servant to the American public to be hastily shelved on the strength of some trifling departmental irregularity. But will the President do him justice, or will he sacrifice him for political exigencies? Time will soon show.

A Leviathan Sugar Cane Mill.

When Messrs. John McNeil & Co., of Glasgow, built the famous "Dreadnought" mill a few years ago for the "Waterloo" Factory in Trinidad, the installation, with its eleven rollers, 36 in. diameter × 72 in. long, was about the largest and heaviest eleven-roller milling plant which had, up till that date, been constructed in this country. Since then, this well-known firm have built a great many large multiple mills, one for Japan having fourteen rollers, 34 in. diameter × 78 in. long, and journals 17 in. diameter. They have, however, now beaten even their own high record, as we learn they have at present in hand for Argentina a fourteen-roller milling plant, having rollers, 40 in. diameter × 84 in. long, all journals being 20 in. diameter × 26 in. long. After an exhaustive examination into the relative merits of the two types of crushers, it was decided by the engineering experts employed by the owners to adopt Messrs. McNeil's patent crusher instead of the Krajewski type. The makers are embodying in this huge plant all their latest improvements in connection with intermediate conductors. These latter, as many proprietors of large milling plants know to their cost, are usually the most troublesome parts of multiple mills, but from their great experience in designing and constructing these large plants, Messrs. McNeil have evolved a type of conductor which is claimed to be practically perfect.

This Brobdingnagian mill is also fitted with their patent "meshing" rollers which have been such a success all over the world, and, in accordance with Messrs. McNeil's usual practice, with pinions on both ends of the roller shafts. The installation is completed with hydraulic safety regulating apparatus applied to all the top rollers and to the crusher; cush-cush elevator of special design; juice pumps for each section of the mill; cane, megass and boiler house conductors with the firm's own automatic arrangement for feeding the boilers.

To those croakers who are always telling us that we are falling behind in the international race for trade, it will be of interest to learn that this important contract was secured in the face of competition

from all the most important sugar machinery firms in the United States, France, Germany and this country, a result principally due, we understand, to the superiority of the design and to the wide experience possessed by the makers in the construction of large multiple milling plants.

A Japanese Sugar Paper.

The Japanese have made such big strides the last few years in the production of sugar, that it is a matter of no surprise to find them starting a sugar publication of their own; the new comer is the *Sugar Industrial World*, a monthly issued at Tokio. Most of its pages are in Japanese, but there are a few pages of English. In the August issue these latter are devoted to some account of the general meetings of sugar companies in Formosa. The Dai Nippon Sugar Company, we learn, has just paid its shareholders 5 per cent. interest; the Ensuiko Sugar Company, 10 per cent. dividend and a further bonus of 10 per cent.; the Toyo Sugar Company, 12 per cent.; the Niitaka Sugar Company, 10 per cent.; and the Taiwan Sugar Company, 10 per cent. plus a bonus of 20 per cent. It will be seen therefore that the Formosan concerns are doing extremely well.

THE SUGAR SCARCITY.

THE POSITION OF RUSSIA.

There is to be a terrible falling off in the production of beetroot sugar in Europe this season—no one yet knows how serious the deficiency may be—and it will be no easy matter to keep up supplies if consumption goes on increasing in a normal way. Even if Russia were allowed to export her whole surplus we should still be in a tight place, especially if Cuba were to have another short, dry weather, crop. But, according to the queer arrangements made on the renewal of the Brussels Convention in 1908, Russia is not allowed to export (except its normal exports to Finland and the East) more than 200,000 tons a year. The origin of this peculiar arrangement throws a curious light on the so-called "Free Trade" principles which still delude our armchair economists.

At the International Conferences at Brussels, in 1901-2, it was at last agreed—after thirty years of hesitation—that Great Britain would accept the only condition on which the Foreign Powers could possibly agree to abolish their bounties. They had declared again and again, ever since the conferences in Paris in 1876-7, that it would be impossible for them to enter into any agreement to abolish their bounties unless Great Britain would give them security, by a Penal Clause in the Convention, that they should no longer have to compete with bounty-fed sugar in British markets. A countervailing duty

was to be agreed to, equivalent to the amount of the bounty, which would restore freedom of competition, and at the same time raise no impediment to the entry of bounty-fed sugar on equal terms with other sugar. Sugar which received a bounty would merely deposit its bounty at our Custom House for the benefit of the British tax-payer, and the sugar would then enter, free from any inequality of conditions.

This was pure free trade. It had been long ago declared by an eminent economist that "a duty to countervail a bounty is not only consistent with free trade but positively conceived in the interests of free trade." But, alas, our Government could not shake off the miserable fallacy that "free trade" meant "duty for revenue purposes only." They accordingly declared that they would agree to the Penal Clause, but that in the case of Great Britain the word "prohibition" must be substituted for the words "countervailing duty." To prohibit the importation of a commodity was, in their opinion, consistent with free trade; but simply to remove the bounty and then allow the commodity to enter was, to their minds, a shocking departure from pure doctrine.

This has been the cause of all our troubles. It began by giving party politicians a splendid cry—restriction of supplies. It now ends by shutting out Russian sugar when we want it badly. This has been brought about in an interesting way. The new British Government, when they had to attend the Conference of 1907 for the purpose of renewing the Convention, began by at once casting the Penal Clause to the winds. It was too shocking for their pure economic morals. This was a rude blow to our Continental colleagues, who had abolished their bounties in good faith that we would carry out our part of the bargain and secure them against bounty-fed competition. But the pure economic mind cares for none of these things. The Foreign Governments were ruthlessly thrown over and left to find their own way out of the quandary. They saw at once that under the new régime Russia, whose sugar industry enjoys a big Cartel bounty and therefore increases its production by leaps and bounds, would flood the British markets in future years with its surplus stocks. It had no stock at the moment, but now it has nearly doubled its production and can give us, next year, a very respectable quantity of its superfluous sugar. They hit upon a clever plan for circumventing this danger by promptly admitting Russia, with her big Cartel bounty, to be a party to the Convention, on condition that her exports were to be limited to 200,000 tons per annum. This scheme when put to the vote was no doubt received by the British delegate with a polite but silent bow.

The British Minister at Brussels, in 1908, put in a reserve stating that the assent of His Majesty's Government to the Protocol was limited to the provisions permitting Russia to adhere to the Conven-

tion and did not imply assent to the stipulation tending to restrict the "importation" of Russian sugar.

It will be interesting to watch the progress of events. Russia asks for a conference in order that she may be permitted, under exceptional circumstances, to increase her exports. What will Germany, Austria, and the others say to this? A member of the Convention for the abolition of bounties, who is also a giver of an enormous Cartel bounty to the sugar industry, asks to be allowed to step into the breach in this time of sugar scarcity, and supply the world with bounty-fed sugar! Quite a Gilbertian situation, and entirely caused by our economists, who prefer sham to real free trade.

George Martineau.

THE REQUIREMENTS OF THE BEET SUGAR FACTORY AS COMPARED WITH THE CANE SUGAR ESTABLISHMENT.

By Ed. Koppeschaar.

When the various beet schemes in this country some day take shape, and the contract for erecting a 600 or 1000-ton factory is let, the British sugar machinery firms, some of whom have been making sugar machinery for half a century, will no doubt be prepared to make a bid for a contract involving some £100,000 of work. We therefore propose in what follows to draw attention to some of the main differences in the beet as compared with the cane installation, and while not pretending to cover the ground so exhaustively that no further assistance will be necessary, it should be some guide to the various types and systems described in the extensive literature on the subject.

Reviewing the two, cane and beet, in our mind, we propose to frame a series of axioms which can be well studied and figured out when designing beet installations:

First: Whereas the sugar cane once cut quickly deteriorates in industrial value, and consequently no larger store of cane is kept near the rollers than will last 24 hours, the sugar beet will lie awaiting its fate far better, and though the importance of quickly working up the whole crop has been frequently pointed out by the writer, a 7 days' store will not occasion the loss such as is caused by irregular beet supplies.

Second: The extraction of the sugar from the beet by the method which has survived, viz., the diffusion battery, calls for special slicing machinery which in turn demands clean beets, thus necessitating a station for the sole purpose of cleaning the beets.

Third: The exhausted beet shreds or pulp are not used as fuel like bagasse, but serve as cattle food. Thus the boilers as well as the

fire-grates are of a different type, and special pulp-drying machinery should form part of the installation.

Fourth: The large amount of lime used, and the necessity of carbonatation, justifies the equipment of lime-kilns.

Fifth: A carbonatation installation, dispensed with in raw cane sugar factories, cannot be omitted in a beet installation.

Sixth: Arising out of axioms 4 and 5, a filter-press station is needed.

Seventh: The different method of sugar extraction, as well as the necessity for sweetening-off the rather great weight of lime cake, calls for a larger heating surface in the evaporating station.

Following our diagramatic scheme of the manufacturing process (this *Jl.*, 1911, 130) we will treat these differences in a somewhat more detailed manner. When making a selection we prefer to draw from practical experience, at the same time giving as far as possible the reasons for our choice.

Though the unloading installation is usually provided by special firms, a few words about it may be offered here. The introduction of unloading machinery of late years is not only due to a desire to reduce expenses, but also, to a great extent, to the fact that it makes the factory less dependent on hand labour. The list of various unloading devices has become a fairly long one; we may divide them as follows:—

Those which unload the beets dry, thus making it possible to store them up.	Electrical gantry crane; Steam or electrical radiating crane; Bucket elevator, driven by some motor or other. Devices which lift a whole railroad car load and dump the contents on the flume, driven by hydraulic or electric force.
Those which unload with the aid of water, thus forcing the beets to be worked up directly.	Mammoth pump. Archimedes screw, driven by motor or otherwise.

Which should be chosen will depend on local conditions; they all do admirable work. The electric gantry cranes, usually fed with 3-phase alternating current from a generator that stands in the factory, covers a broad range of flumes and is easy to handle. The radiating steam cranes are quickly gaining their way, as they are independent of the factory, and can also serve to unload coal and limestone in the summer.

The Mammoth Pump has proved useful wherever installed, (see this *Jl.*, 1911, 360). The writer has had occasion to work with it for a

few campaigns and though the useful effect is only about 25 per cent., its indirect usefulness in saving hand labour and in the absence of stoppages and repairs has all been in its favour.*

1. A seven days' storage of beets should be provided for, and in treating this item, we must at the same time touch on the means of transport from the stores to the factory. The specific gravity of the sugar beet being about equal to that of water, this last medium was early brought into requisition to transport the beets to the factory. The fall-water (about 700 per cent. of the weight of the beet) from the central condenser is sufficient to do this work. The flumes in which a valve at the top end admits the water from the central condenser are best constructed on the spot, from reinforced concrete, reinforced because when they do not "swim" the beets, an iron plate covers them, bearing a beet-pile some three to five yards high. The side pressure of this beet-pile on the space between two flumes has been known to break the walls of the flume thus reducing the cross-section of the beet flumes by half.

As to the desired outflow, figuring for a future larger factory capacity, a 16in. × 16in. section of flume will do for a 600-ton factory; and a 20 in. × 20 in. will give ample supply for a 1000-ton factory.

We said the specific gravity of the beet was about equal to that of water, but in fact it is a little higher, adhering dirt and sand will augment it,† so the beets do not really float but are pushed towards the factory. This makes it clear why a falling grade of 1·2 per cent.‡ along the straight, and 1·5 per cent. at the bends, give the best guarantee to avoid banks formed of mud and tangled beets, and the consequent stoppages. For the same reason a certain pressure of the inflowing water (9 to 12 lbs. per square inch) and a special valve for each separate flume work beneficially. The curves of the flumes should have a 7 to 9 yards radius; and their arrangement will depend on the topographical conditions. The English climate does not justify the building of storing sheds, and the best way to arrange the flumes is with cemented sides slanting 30°, the flumes lying parallel to one another.

Before the factory is entered a simple frame of iron bars should be built in, in order to catch stones and pieces of iron.

2. Though the beets are partly cleaned by the constant rubbing against one another in the warm fall-water (which has a temperature of 30 to 40° C.) a special station is needed to finish this cleaning

*For factory owners I would draw attention to the fact that where Mammoth Pumps are used, there is a tendency for the beets, otherwise unloaded, to remain too long stored up. They should stay on the beet flumes as short a time as possible.—*E. K.*

†Maximum tare should not exceed 10 per cent., but with beets harvested from heavy clay in a rainy season, it sometimes runs higher.

‡ To be considered as the minimum.

process. The washing tank in which this takes place needs a certain elevation above the floor in order to discharge the mud and stones, while the discharge end of the beet flumes, owing to the gradiant needed, may be a few yards below the floor. To lift the beets the required height, a lifting wheel (see *Fig. 1*) with scoops on its circumference is preferable to an Archimedes screw, as a wheel requires less force and seldom or never causes stoppages, since it wears very little and breakages do not need to occur. Its construction is a simple one of sectional iron bars and sheet iron, the scoops being perforated or not, depending on whether the water is to be lifted as well or not. As it is better to separate the beets from the water that has carried them so far, it being loaded with dirt and sand, and to supply fresh wash-water to the washer, the best plan is to fit the scoops with perforations. The water is then lifted by a special water wheel or pump. Care should be taken that the beets are discharged

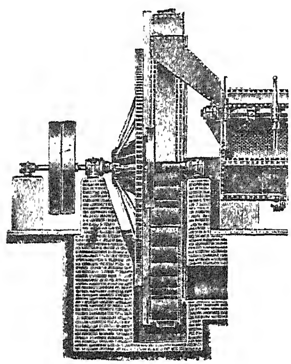


FIG. 1.

into the scoops and have no chance to fall back into the cellar. The discharging of the beets from the wheel into the washer is effected by aid of a sheet-iron slanting funnel. The diameter of course depends on the height the beets must be lifted; the writer has seen wheels up to 11 yards in diameter which could be turned easily by a boy. The revolutions are few, the maximum being 5 per minute. The washer must deliver the beets perfectly clean, and without stones or other undesirable impediments.

Now having enunciated the important features, the construction of the washer may be considered. Within a strong iron box, measuring say 9 × 2 × 2 yards, a semi-circular basket of perforated sheet iron is constructed divided midway. The beets are pushed forward by a revolving axle bearing wooden palettes fitted spirally, which makes 15 to 20 revolutions per minute. The perforated sheet-iron bottom has an open space in front of the middle and the end partitions to

give the stones an outlet underneath. Valves with suitable handles occasionally discharge the mud and stones. A fresh water spray should be applied at the further end of the washer to thus bring clean beets into contact with clean water. The washer discharges the beets first on to a hopper, built of perforated sheet iron, which feeds the elevator very evenly; and the hopper measuring 6 $\times$ 1 yards is large enough to enable any stones or pieces of iron, which may have come along, to be picked out by hand. The tail ends are best caught by a revolving drum of perforated iron through which the discharge water of the washer has to pass. In the inside a set of strong brushes keeps the perforation open while at the inlet of the drum an elevator takes the tail ends upwards to a special slicer.

Before the battery can extract the sugar, the beets are weighed and sliced. This makes necessary an elevator; of the various types, the perpendicular bucket elevator, moving over two drums 1 yard in diam., and held together by a double set of strong chains, will occasion no disappointment.

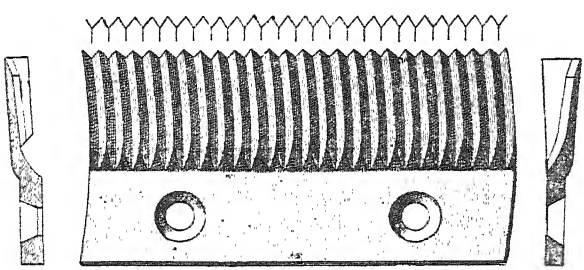


FIG. 2.

In larger factories, *i.e.* those working more than 1000 tons per 24 hours, the task of elevating the beets should be assigned to a double set; in a beet sugar factory every guarantee should be forthcoming that no serious breakages can cause a stoppage, but with the tremendous wear and tear of a day and night industry like this, in a factory having great capacity the reserves should be such that the factory can always work through, even though with restricted output, when a breakage occurs.

The elevator should receive the beets about 1 yard above the lower drum axle, and the discharge funnel should be fixed 1 yard underneath the upper drum axle. Although the beet weight may be calculated with fairly good accuracy, the usefulness of an automatic weighing scale is questioned by no one; and so we would recommend it, taking care that a sufficient slant is arranged to allow an efficient discharge.

The important process of changing the beets into slices (*cossettes* we generally call them) is entrusted to a pair of slicing mills in a 600-ton factory, and to three, and better still four, in a 1000-ton factory.

The so-called knife (see *Fig. 2*) that accomplishes this, is not a real knife but a flat piece of steel pressed out and sharpened, which is fastened in a box (see *Fig. 3*) in such a way that it can be adjusted forwards and backwards, upwards or downwards. A number of these boxes, say 16, are inserted radially into a round frame two yards in diameter (see *Fig. 4*), making some 60 to 70 revolutions per minute. Smaller discs can produce equally good work if the circumferential velocity is at least 16 feet per second.

To keep the beets in place an iron partition 18 in. high and one-eighth of an inch distance from the knives, is fixed in three places. In order to have sufficient pressure the beet pile above the disc should be 5 feet thick. Those slicers in which the beets are forced into a wedge-shaped funnel do not thereby slice more beets, but the boxes are easy to exchange and foreign substances, stones, &c., are quickly found.

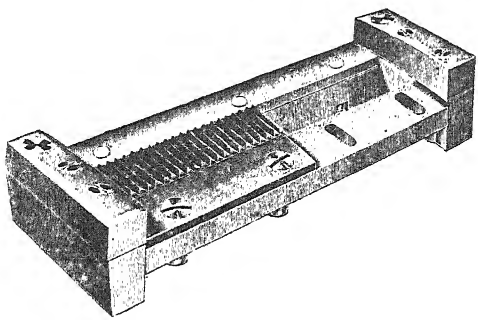


FIG. 3.

The best place to fit the driving gear is underneath, and one of the moving wheels should have wooden teeth. The knife boxes should be constructed in such a way that the constant changing and adjusting require as few screws as possible to remove.

For the factory owner the slicing station holds the key to a good sugar extraction, and while in regard to knives and systems of slicing "many ways lead to Rome," the fabricant should see that none but good clean beets get into the machine, and that the knives are kept in good working order, so that none other than long well-shaped cossettes go to the battery. A belt transporter brings the cossettes within reach of the battery cells, which, being a special feature of the factory, deserve to be referred to at some length.

Of the two available methods of extraction, viz., crushing, and diffusion into surrounding water (or *osmosis* as it is termed), the

latter only has survived, not merely because of its simplicity of treatment, but also on account of its far greater percentage yield of sugar. Indeed the reason that the diffusion battery has been given a chance to prove its effectiveness for cane as well is solely due to the increased yield obtained thereby. Taking an instance from actual practice, we find that this extraction attains about 96 per cent. of the available sucrose.

Sugar in the beet	16·59 per cent.
Litres of raw juice drawn from 100 kg. beets.	103
Volume per cent. raw juice	15·45
Sugar per cent. on the beets	15·91
Extraction	95·9
Loss..	4·1

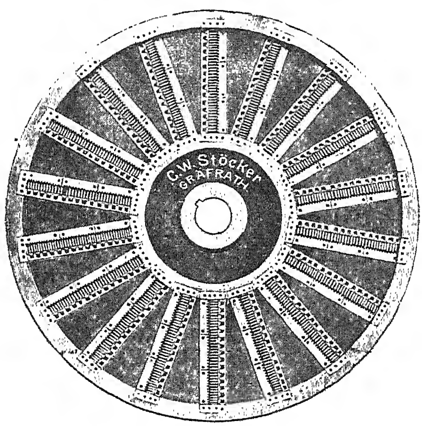


Fig. 4.

Comparing this with cane extraction, we find in Mr. Maxwell's treatise on this subject:—

Entering mills, 113

Cane, 100 — Imbibition water, 13
Containing 13·33 sugar

Exit mills, 113

Mixed juice, 89·6 — Bagasse, 23·4
Containing 12·332 sugar — Containing 4·5 sugar

Extraction ..	92·13 per cent.
Loss	7·87 ,,

In Prinsen Geerligs' work we find the extraction given as 93 per cent. (imbibition 14 per cent.); while for cane diffusion he gives 94-95 per cent.

But though the superiority over crushing as to yield has been shown, a variety of reasons has remained to induce the retention of crushing for cane, and the diffusion battery must be regarded as a special characteristic of the beet sugar factory alone.

In the battery, which is a series of cylindrical iron cells, the sugar in the beet cossettes is brought into contact with surrounding water.

Of the cells, of which the beet slices are composed, many have been already opened up by the beet knives; from these the contents, sugar as well as non-sugar, will readily dissolve into the surrounding water. From those cells which are left intact, the contents will pass through the surrounding cell walls, when the application of a temperature of about 70° C. has changed the protoplasm, and the wall acts like a membrane of parchment paper, through which the sugar readily passes into the surrounding fluid.

This diffusion or osmosis will take place until the fluids inside and outside are equal in concentration, thus making necessary a series of battery cells which form a circuit, but in which the concentration of the surrounding fluid is gradually decreasing; fresh cossettes meet a concentrated sugar solution, staler ones weaker solutions, and so on, until finally the nearly-exhausted cossettes meet water as the surrounding fluid.

Of the many widely differing types of batteries* the battery of 15 to 16 cylindrical cells, discharging at the bottom, is winning its way.

The straight line 16-cell battery, divided into two rows of eight cells, has marked advantages for the transport of both cossettes and pulp.

A short battery needs higher temperatures, which not only require more steam but tend to soften the cossettes, and when working soft beets lead to stoppages. When working up sound beets in a 16-cell battery, a good extraction and low "juice-draw"† can be obtained with 13 cells in circulation, the three remaining cells being kept in reserve to be filled with cossettes, when the battery has to stop for a short time. The cylindrical body of the cell, in which the ratio of diameter to height is as 1 to 1·5, has a conical top with cover and a conical bottom-piece with cover and sieve.

It may be well here to refer to what goes on when the battery is working. When the cell, just charged with fresh cossettes, has been filled with a fairly concentrated sugar solution from the adjoining cell, the next thing we do is to draw off this same quantity of juice, a

*The capacities vary enormously; in Austria, through fiscal interference, the cells used to measure a few hectolitres, even 1·5 hectolitres was to be found. Batteries of 60 to 80 hectolitres are now frequently met with, and recently a 115-hectolitre battery has come to our notice.

†The number of litres raw juice drawn from 100 kilogrms. of beets.

few percentages of sugar the richer, to the measuring tank. The question as to how much should be drawn being of great importance to the factory owner, is also of importance to the designer of the batteries.

The more concentrated we can obtain our raw juice, the less water has to be evaporated in the evaporators. If the cells are small, little time is left to compress* the cossettes into the cell; in larger cells, if the beet cossettes are sound, the quantity of cossettes that can be charged into a cell may exceed 50 kilogrms. per hectolitre, and sometimes reaches 60 kilogrms. As the amount of juice we should draw is determined by the cell-contents minus the contents taken in by the cossettes, it is evident that the more cossettes we introduce into the cell the less we can draw off, at the same time the raw juice drawn off will have come into contact with a larger quantity of cossettes, consequently will be more concentrated.

Further, the interchange of fluid will be better if we charge more heavily, thus favouring the osmosis.

Given a cell capacity of..	65 hl.	65 hl.
Charged to	55 kg. per 1 hl.	58 kg. per 1hl.
Sp. Gr. $\frac{95 \times 1{\cdot}075^{\dagger} + 5 \times 1{\cdot}5^{\ddagger}}{100}$	$= 1{\cdot}09$	$1{\cdot}09$
Total charge	55×65 kg.	58×65 kg.
Contents.. .. .. .. $\frac{55 \times 65}{1{\cdot}09}$	$= 32{\cdot}8$ hl.	$34{\cdot}6$ hl.
Juice drawn	36 hl.	36 hl.
Cells in circulation	13	13
Per cent. drawn of total juice ..	$\frac{100 \times 36}{13 \times [65 - 32{\cdot}8]}$ = 8·6 per cent.	$\frac{100 \times 36}{13 \times [65 - 34{\cdot}6]}$ = 9·1 per cent. §
Juice drawn per	3575 kg. beets=3600 litres = about 100.	per 3770 kg.=3600 litres = about 96.

In practice, however, the larger factories divide the work and generally have two separate batteries. The writer has worked this way in a satisfactory manner 1·2 million kilogrms. beets in a double set of batteries, each battery consisting of 15 cells of 65 hectolitres capacity each. However, as already stated, other factories reach equally good results with a single battery of correspondingly larger capacity, others with three batteries, so any fixed rule is difficult to make.

---

* Performed by hand with the aid of strong sticks, and by trampling with the feet.

† Sp. gr. of juice. ‡ Sp. gr. of marc.

§ Thus when charging 58 kg. instead of 55 kg. per hectolitre we draw 9·1 per cent. instead of 8·6 per cent. of the total amount of juice. Practically, even with irreproachable cossettes, a draw of 100 to 103 forms the limit.

A single battery stands for economy as regards handling, space, cost, &c., and where the battery seldom or never gives rise to stoppages,* the need of a double set of batteries is difficult to justify.

As to the size of the cells, for any given capacity, we may assume as a starting point that as determined by practice from 95 to 100 minutes' treatment of the cossettes within the cell will enable us to draw concentrated juice, while leaving only 0·2 to 0·3 per cent. of sugar in the pulp. If we adopt 95 minutes as the period, what will be the size of a cell for a 16-cell battery, to be designed for a 1000-ton factory? In order to reach the campaign average of 1000 tons and allow for future increase in capacity, we must figure on 550,000 kilogrms. per 12 hours. If 13 cells are constantly in circuit (*i.e.*, one being emptied, one empty, one being filled) they will be filled $\frac{12 \times 60}{95} =$ 7·58 times. The total charge of the battery will be $\frac{550{,}000}{7{\cdot}58} = 72{,}560$ kg.

The charge of a cell will be $\frac{72{\cdot}560}{13} = 5581$ kilogrms.

Assuming a charge of 55 kilogrms. per hectolitre of cell content, the size will be $\frac{5581}{55} =$ *circa* 102 hectolitres.

We have already mentioned that the application of heat† is needed in order to effect osmosis.

Of the two different ways in which steam is applied, the injectors are no doubt the most simple. We do not dispute the economy obtained by heaters, receiving steam from the first body of the evaporators, but the great chance of loss of sugar and the difficulty of changing the pipes during working operations, are all in favour of injectors, while the alleged dilution of the juice has not yet been proved.

For preserving cane juice in the case of stoppage of the factory, M. Fouquereaux de Froberville states (*Bulletin, Mauritius, 1911, 2, 75*) that he has obtained excellent results with 40 per cent. formol in the proportion of one in 10,000, no trace of alteration having set in for 48 hours. With scums and "bottoms," preservation could be effected for the same time by using the antiseptic to the amount of one part in 4,500, care being taken to mix well.

---

* As, for example, when a rubber ring from the under cover gives way. When bad circulation occurs, the cause will be the same for both batteries, so they will both cause trouble, e.g. when the slicers make mushy cossettes, or soft, rotten beets are worked up.

† The question of the amount of steam required we propose to deal with separately in a subsequent article.

THE WORLD'S SUGAR TRADE.

STATISTICS RELATING TO THE PRODUCTION OF SUGAR IN THE VARIOUS PRODUCING COUNTRIES OF THE WORLD; AND TO THE IMPORTS AND EXPORTS, AND THE CONSUMPTION OF THE SUGAR PRODUCED.

An interesting White Paper (No. 281, 1911) has just been issued by the Board of Trade in response to a request made in the House of Commons for a Return showing, as far as possible, for each of the years 1907, 1908, 1909, and 1910, inclusive, the estimated production of cane and beet sugar, respectively, in the various producing countries of the world; the imports and exports of raw and refined sugar, distinguishing beet and other sorts from and to the principal countries of origin and destination; the total consumption and consumption per head of the population; and the exports of sugar of domestic production from each of the principal British colonies and possessions, together with the average declared import value of raw and refined sugar for the United Kingdom (in continuation of Parliamentary Paper, No. 334, of Session 1907).

We reproduce below certain of the most interesting of these tables; but as regards the rest content ourselves with referring in the subjoined notes to the most important points tabulated in them.

In their *Preface* the Board of Trade remark that the actual production of sugar in the world is not *exactly* known, owing to the difficulty of collating figures from some of the cane sugar countries. They are therefore forced to fall back in some cases on the estimates of Messrs. Willett & Gray.

The quantities are given in more than one measure, *long tons* and *metric tons* predominating. It is a pity, however, that the Board of Trade should persist in giving the figures relating to the United Kingdom, Canada, and Australia in *hundredweights*. The sugar trade is accustomed to think in *tons*, and nothing is gained by giving them quantities reckoned on an obsolete basis of measurement. We have accordingly changed the figures concerned into tons, as will be seen below.

SUMMARY STATEMENT SHOWING THE ESTIMATED QUANTITY OF RAW CANE AND BEET SUGAR PRODUCED IN THE WORLD, DISTINGUISHING THE PRINCIPAL SOURCES OF SUPPLY.

PRINCIPAL SOURCES OF SUPPLY.	1907.	1908.	1909.	1910.
CANE SUGAR:—	Tons.	Tons.	Tons.	Tons.
In the British Empire:—				
Mauritius	181,526	181,534	198,214	244,597
British West Indies and British Guiana ..	253,634	254,986	217,849	219,946
Other British Possessions..	310,651	264,450	294,313	294,634
Total British Empire (excluding India)..	745,811	701,270	710,376	759,177
British India	2,205,300	2,046,900	1,872,900	2,125,300
Total British Empire (including India)..	2,951,111	2,748,170	2,583,276	2,884,477

PRINCIPAL SOURCES OF SUPPLY.

	1907. Tons.	1908. Tons.	1909. Tons.	1910. Tons.
CANE SUGAR:—				
In Foreign Countries:—				
United States..	243,000	352,000	325,000	335,000
West Indies (other than British):—				
Cuba	1,427,673	961,958	1,513,582	1,804,349
Other parts..	348,461	393,356	426,083	503,953
South America	548,598	535,331	620,335	587,829
Dutch East Indies	1,062,795	1,114,186	1,189,420	1,200,618
Hawaii	464,677	477,190	489,357	462,613
Other Foreign Countries..	599,105	636,861	710,688	881,624
Total Foreign Countries	4,694,309	4,470,882	5,274,465	5,775,986
Total estimated production of Cane Sugar..	7,645,420	7,219,052	7,857,741	8,660,463
BEET SUGAR:—				
In Europe:—				
Seven principal producing Countries* ..	6,137,269	6,148,227	6,185,346	5,724,030
Minor producing Countries	429,603	450,623	507,457	425,189
In the United States	432,234	413,950	384,010	457,562
Total estimated production of Beet Sugar..	6,999,106	7,012,800	7,076,813	6,606,781
Total estimated production of sugar in the World	14,644,526	14,231,852	14,934,554	15,267,244

DETAILED STATEMENT SHOWING THE ESTIMATED QUANTITY OF RAW CANE SUGAR PRODUCED IN THE BRITISH EMPIRE.

COUNTRY OF PRODUCTION.	1907. Tons.	1908. Tons.	1909. Tons.	1910. Tons.
Mauritius	181,526	181,834	198,214	244,597
Commonwealth of Australia	217,479	165,715	147,470	149,334
Fiji..	68,334	66,137	68,942	68,900
Natal..	24,223	31,993	77,491	76,000
West Indies:—				
Jamaica	28,481(b)	24,000(b)	18,823(b)	12,000
St. Lucia	5,364(c)	4,982(c)	5,518(c) }	5,500
St. Vincent	298(b)(c)	223(c)	288(c) }	
Barbados	38,033	36,353	17,795(c)	36,389
St. Christopher and Nevis	14,879	11,744	12,321 }	20,000
Antigua	14,774	13,316	9,171 }	
Trinidad and Tobago	50,564	48,933	45,330	44,139
Other West Indian Islands	504	223	70	75
British Honduras..	615(e)	605(c)	410(e)	400
British Guiana (c)	100,737(b)	115,212(b)	108,533(b)	10[illegible]
Total British Empire (excluding India)	745,811	701,270	710,376	759,177
British India	2,205,300(d)	2,046,900(d)	1,872,900(d)	2,125,300 (d)
Total British Empire (including India)	2,951,111	2,748,170	2,583,276	2,884,477

NOTE.—The above figures are exclusive of sugar produced from sources other than sugar cane. Certain quantities of such sugar are produced in British India, the Commonwealth of Australia, and the Dominion of Canada. Some *cane*-sugar is also grown in the Straits Settlements; but the quantity produced or exported cannot be stated.

(a) The Colonial Authorities state that the figures given represent the quantity in bags of sugar received in Port Louis from sugar estates. Conversions have been made at the rate of 74 kg. per bag.

(b) For the 12 months ended 31st March of the years *following* those dated.

(c) Domestic exports—production figures not being available.

(d) Years ended 31st March. The figures represent the production, on the average, of about 98 per cent. of the area under "sugar-cane" only.

(e) Incomplete.

* Russia, Germany, Holland, Belgium, France, Austria, and Hungary.

Detailed Statement showing the Estimated Quantity of Raw Cane Sugar produced in Foreign Countries.

Country of Production.	1907. Tons.	1908. Tons.	1909. Tons.	1910. Tons.
Europe:—				
Spain	16,400	14,047	21,669	23,033
Africa:—				
Egypt	42,195	55,648	49,625	52,525
Réunion	37,500	37,000	41,500	36,000
United States	243,000	352,000	325,000	335,000
Mexico and Central America:—				
Mexico	119,496	123,285	143,179	147,905
Guatemala	7,469	7,178	7,260	7,110
San Salvador	6,008	5,490	6,241	6,356
Nicaragua	3,905	4,175	3,950	3,450
Costa Rica	2,365	2,415	2,245	2,245
Foreign West Indies:—				
Cuba	1,427,673	961,958	1,513,582	1,804,349
Porto Rico	199,737	244,678	279,632	308,000
Haiti and San Domingo	60,000	62,235	69,483	93,003
Guadeloupe	38,960	37,500	25,211	48,000
Martinique	36,764	35,943	37,757	39,950
Danish West Indies (St. Croix)	13,000	13,000	14,000	15,000
South America:—				
Venezuela	3,000	3,000	3,000	3,000
Dutch Guiana (Surinam)	11,738	11,806	10,756	12,055
Brazil	215,000	180,000	248,000	253,000
Argentine Republic	111,604	159,089	162,479	123,674
Paraguay	600	600	600	600
Chile	38,000	38,000	38,000	38,000
Peru	161,156	135,336	150,000	150,000
Ecuador	7,500	7,500	7,500	7,500
Asia, East Indies, &c.:—				
Siam	7,000	7,000	7,000	7,000
French Indo-China	49,000	49,000	49,000	49,000
China	80,000	80,000	80,000	80,000
Japan*	50,070	49,182	53,143	58,000
Formosa	55,720†	61,228†	123,876†	204,000‡
Dutch East Indies	1,062,795	1,114,186	1,189,420	1,200,618
Philippine Islands	121,977	141,213	122,000	205,000
Hawaii	464,677	477,190	489,357	462,613
Total estimated Output of Cane Sugar in Foreign Countries	4,694,309	4,470,882	5,274,465	5,775,986

Detailed Statement showing the Estimated Quantity of Raw Beet Sugar produced in Foreign Countries.

Country of Production.	1907. Tons.	1908. Tons.	1909. Tons.	1910. Tons.
Russia	1,391,923	1,522,384	1,522,041	1,255,345
Germany	2,206,012	2,104,358	2,045,805	2,004,653
Holland	201,819	176,035	215,224	191,691
Belgium	277,317	227,830	253,220	244,411
France	754,746	734,291	793,436	802,341

* Years ended 31st March. † Exports in the calendar year stated.
‡ Production in 1909-10.

Country of Production.	1907.	1908.	1909.	1910.
	Tons.	Tons.	Tons.	Tons.
Austria-Hungary :—				
Austria ..	1,001,686	1,116,707	1,079,473	1,225,589
Hungary ..	303,766	266,622	276,147	
Sweden ..	150,798	110,138	134,497	124,959
Denmark ..	51,814	65,230	64,398	63,955
Italy..	104.673	133,781	162,655	109,014
Spain ..	93,144	106,612	108,232	81,666
Other European Countries	29,174	34,862	37,675	45,595
Total for Europe..	6,566,872	6,598,850	6,692,803	6,149,219
United States ..	432,234	413,950	384,010	457,562
Total estimated Quantity of Raw Beet Sugar produced in Europe and the United States..	6,999,106	7,012,800	7,076,813	6,606,781

Note.—The particulars relate to production seasons ending in August of the years stated, and have been compiled mainly from the official returns of the countries named.

The quantities given are stated in terms of *raw* sugar. Where necessary refined sugar has been converted into its estimated equivalent of raw sugar on the assumption that 100 tons of raw yield about 90 tons of refined sugar.

For Russia the quantity "produced" includes the quantity of sugar held in the "inviolable" reserve as well as a portion of the "free" reserve.

United States.

(1) Total Imports of Sugar.

(Note.—These particulars relate to years ended 30th June.)

Description of Sugar and Country whence Imported.	1907.	1908.	1909.	1910.
Raw Sugar (under No. 16 Dutch standard) :—	Tons.	Tons.	Tons.	Tons.
Beet Sugar :—				
From Germany..	145,021	86,864	42,922	1
,, Netherlands ..	—	—	—	—
,, Belgium ..	29,403	1,990	1,107	—
,, United Kingdom ..	—	301	—	—
,, France ..	—	—	—	—
,, Austria-Hungary ..	3,134	9,521	—	—
,, Other Countries ..	7	1	—	—
Total ..	177,565	98,677	44,029	1
Cane Sugar :—				
From United Kingdom ..	—	702	14,975	838
,, Turkey in Africa, Egypt, &c.	—	—	—	—
,, China and Hongkong ..	444	339	600	517
,, Dutch East Indies ..	200,304	263,250	409,312	140,559
,, Philippines ..	11,234	17,146	37,343	78,513
,, British West Indies ..	8,315	11,424	6,880	410
,, Cuba..	1,444,851	1,030,888	1,277,695	1,566,811
,, Danish West Indies ..	9,315	11,897	3,860	7,541
,, Porto Rico ..	*	*	*	*
,, San Domingo ..	32,853	40,126	32,004	1,012
,, Mexico ..	2,840	12,551	1,682	181
,, Guatemala ..	1,348	1,346	949	1,138
,, Peru ..	15,714	8,362	9,092	8,710
,, Brazil ..	24,037	251	11,329	3,063
,, British Guiana ..	23,227	120	12,974	8,157
,, Dutch Guiana ..	5,003	4,777	3,921	6,677
,, Hawaii ..	*	*	*	*
,, Other Countries ..	207	402	1,009	1,068
Total ..	1,779,692	1,403,581	1,823,625	1,825,195
Total Imports of Raw Sugar.	1,957,257	1,502,258	1,867,654	1,825,196

* The commerce between the United States and Hawaii and Porto Rico respectively, is not included in the statistics of the trade of the United States with foreign countries. The shipments of sugar from Hawaii and Porto Rico *to the United States* have been as follows :—

	1906–7.	1907–8.	1908–9.	1909–10.
Shipments of sugar to the United States :—	Tons.	Tons.	Tons.	Tons.
Hawaii ..	366,526	481,060	456,637	495,803
Porto Rico ..	182,210	209,467	218,060	254,036

Description of Sugar and Country whence Imported.	1907.	1908.	1909.	1910.
REFINED SUGAR (over No. 16 Dutch standard):—	Tons.	Tons.	Tons.	Tons.
From Russia	—	—	—	—
,, Germany	269	639	480	341
,, Netherlands	197	—	220	—
,, Belgium	349	199	100	—
,, United Kingdom	151	169	11	1
,, France	10	100	158	54
,, Austria-Hungary	1,288	607	679	424
,, China	49	78	52	34
,, Hongkong	16	27	17	11
,, Canada	1,046	1,250	762	898
,, Other Countries	11	28	143	963
Total	3,386	3,097	2,622	2,726

DOMINION OF CANADA.

(1) Imports of Sugar.

Countries whence Imported.	Nine months ended 31st March, 1907.	Years ended 31st March. 1908.	1909.	1910.
	Tons.	Tons.	Tons.	Tons.
From United States	9,916	16,144	11,820	14,743
,, "British Africa"	—	—	15,097	15,320
,, Australasia	—	1,189	—	—
,, Fiji	4,780	22,534	4,811	4,825
,, British West Indies	34,081	121,372	105,946	67,168
,, British Guiana	63,453	40,150	32,190	64,084
,, Other British Possessions	1	147	310	524
,, Germany	—	—	988	11,862
,, Dutch East Indies	17,764	6,698	11,363	5,980
,, Belgium	301	4,927	7,419	6,419
,, France	—	—	13	16
,, Austria-Hungary	5	3,449	13,817	2,983
,, United States	213	182	2,254	6,759
,, Cuba	—	—	—	5,183
,, Brazil	—	—	—	172
,, Other Parts of South America	—	—	531	803
,, San Domingo	—	—	1,548	15,810
,, Other Foreign Countries	39	1,022	832	3,352
Total	130,553	217,814	208,939	226,003

(2) Exports of Sugar.

Countries to which Exported.				
To United Kingdom	251	—	—	7
,, British Possessions	24	38	40	43
,, United States	30	5	16	23
,, Other Foreign Countries	2	—	51	296
Total	307	43	107	369

ESTIMATED TOTAL CONSUMPTION OF SUGAR IN VARIOUS COUNTRIES.

Country.	Description of sugar in which the particulars are expressed.	1907. Tons.	1908. Tons.	1909. Tons.	1910. Tons.
United Kingdom	Raw and refined (net imports).	1,693,659	1,629,175.	1,723,270	1,673,204
	In equivalent of refined	1,539,288	1,520,436	1,598,272	1,564,076
Germany	Refined	1,024,885	1,056,662	1,103,779	1,116,012
Netherlands	Refined	92,192	92,472	98,094	99,446
Belgium	Refined	83,949	88,996	93,424	96,878
France	Refined	565,592	575,244	594,637	598,357
Austria-Hungary	Refined	467,501	475,130	502,198	534,165
United States*	Mainly raw sugar	3,165,031	2,942,332	3,251,502	3,285,771
Dominion of Canada	Raw and refined	208,709†	214,974†	222,227†	Not yet available.
Commonwealth of Australia	Raw and refined	204,924	170,177	238,840	,,

* For years ended 30th June. The figures include sugar brought into the United States from Hawaii, Porto Rico, and the Philippine Islands.
† For years beginning 1st April.

Estimated Consumption of Sugar per Head of Population.

Country.	Description of sugar in which the particulars are expressed.	1907. Lbs.	1908. Lbs.	1909. Lbs.	1910. Lbs.
United Kingdom	Raw and refined (net imports).	86·03	81·92	85·77	82·43
	In equivalent of refined	78·19	76·45	79·55	77·05
Germany	Refined	37·01	37·62	38·75	38·61
Netherlands	Refined	36·17	35·79	37·43	37·25
Belgium	Refined	25·98	27·24	28·33	29·12
France	Refined	32·28	32·85	33·92	34·13
Austria-Hungary	Refined	21·73	21·87	22·88	24·09
United States*	Mainly raw sugar......	81·19	74·11	80·43	79·90
Dominion of Canada....	Raw and refined	70·24†	67·03†	66·46†	Not yet available.
Commonwealth of Australia	Raw and refined	109·37	89·16	122·31	,,

Mauritius.

Detailed Statement showing the quantity of Raw Sugar (Domestic Produce) Exported from Mauritius in each of the Years 1907 to 1910, inclusive, distinguishing the Principal Countries to which Exported.

Countries to which Exported.‡	1907.‡ Cwts.	1908. Cwts.	1909. Cwts.	1910.
United Kingdom	550,247	376,035	398,830	Not yet available.
Cape of Good Hope	499,016	408,170	239,208	
Natal	53,886	30,896	5,673	
Zanzibar Protectorate	737	1,524	4,562	
Aden	7,320	4,378	7,631	
British India..	2,474,022	2,713,003	2,289,898	
Ceylon	1,176	400	994	
Hong Kong	31,072	—	59,252	
Commonwealth of Australia	87,570	55,177	68,028	
Dominion of Canada	—	255,698	310,279	
Other British Possessions..	7,305	8,058	125,036§	
France	979	128	10,017	
Delagoa Bay	51,431	24,439	10,045	
United States	—	—	—	
Other Foreign Countries	88,341‖	848	937	
Ship's Stores..	—	—	—	
Total	3,853,102	3,878,754	3,530,390	

British West Indies.

Supplementary Statement showing the quantity of Raw Sugar (Domestic Produce) Exported from the British West Indies, and British Guiana, Separately and as an Aggregate, in each of the Years 1907 to 1910, inclusive.

Years.	British West Indies *excluding* British Guiana. Cwts.	British Guiana. (a) Cwts.	British West Indies *including* British Guiana. (a) Cwts.
1907	2,503,246	2,014,740	4,517,986
1908..	2,209,864	2,304,251	4,514,115
1909	1,991,659	2,170,662	4,162,321
1910..		Not yet available.	

(a) The figures for British Guiana are for years ended 31st March of the years following those stated.

* For years ended 30th June. The figures include sugar brought into the United States from Hawaii, Porto Rico, and the Philippine Islands.

† For years beginning 1st April.

‡ It is stated in the Trade Returns for 1907 and subsequent years that the Exports are classified according to "Countries of Destination." Prior to 1907 "Countries to which Exported" were shown.

§ Including 115,196 cwts. exported to St. Vincent.

‖ Including 87,795 cwts. exported to the Argentine Republic.

From the other tables the following facts may be gleaned:—

In 1910 France imported all but 140,000* tons of raw sugar, of which only 2,167 tons were beet. The three largest sources of supply were Réunion (37,212 tons), Martinique (41,980 tons), and Guadeloupe (43,184 tons). The imports of refined sugar amounted to barely 2000 tons. The exports of raw sugar came to 64,705 tons, of which 56,900 tons went to the United Kingdom; while the refined amounted to 127,199 tons (as compared with 155,165 tons in 1909), the two principal customers being Morocco and Algeria. As showing the decrease in the exports of raw sugar, it may be pointed out that in 1907 the amount was 170,945 tons, Great Britain taking 147,313 tons.

Germany's export of sugar in 1910 amounted to 264,100 (metric) tons raw and 435,396 tons refined; Great Britain was the principal customer, taking 201,948 tons raw and 289,889 tons refined, while Norway and Switzerland took large amounts of refined (38,693 and 28,110 tons respectively). No sugar went to British India. As compared with 1907, however, the figures of total exports show a big decrease, aggregating some 215,000 tons. The imports were negligible.

Austria-Hungary's total of exports for 1910 came to 82,553 tons raw (as compared with 157,738 tons in 1909) and 573,068 tons refined (639,261 in 1909). The United Kingdom was the principal customer for raws (59,580 tons) and also for refined (246,585 tons), but there were three other important buyers for refined, viz., Switzerland (58,400 tons), British Possessions in Mediterranean (96,278 tons) and British India (90,281 tons).

Australia in 1909 imported 99,698 tons of raw cane sugar, 75,016 tons from Java and smaller amounts from Fiji, Mauritius and other countries; the exports amounted to 8405 tons and went chiefly to British South Africa and New Zealand.

INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY, WASHINGTON, SEPTEMBER, 1912.

We have received a print embodying a summary of suggested requirements and mutual obligations between the International Congress of Applied Chemistry to be held in Washington next September and prospective authors of contributions. This summary has been compiled by the Congress authorities in response to numerous requests for information in a concise and compact form of the Rules and Regulations. These latter are not however final, and any criticisms, accompanied by suggested remedies, if received by the Secretary of the Congress at 25 Broad Street, New York City, *before December 1st*, will be duly considered.

The rules total 23 in all and we cannot find space to reproduce them *in extenso*; but the following are some of the most important.

* The figures given of Continental trade are all in *metric tons* of 2200 lbs.

All papers must be in duplicate and legibly written, preferably typewritten. Each sheet must be written on one side only and not on both sides.

Each paper must be accompanied by an abstract thereof, also legibly written, preferably typewritten, and which must be in duplicate.

Papers and their abstracts, both in duplicate, must be in the hands of the American Committee not later than June 30th, 1912.

All papers or like contributions must be as concise as possible and must contain the full name and post-office address of their respective authors; further, what number, if any, of reprints of the paper or like contribution is desired (50 copies gratis).

Papers or other like contributions must be original and not elsewhere read or published, nor contributed or offered to any other Society, Association or publication for presentation or publication. No paper should deal with historical matter any more than is needful for a proper understanding of the new subject matter presented, which subject matter, as far as practicable, should be of a date subsequent to June, 1909, the date of the Seventh International Congress of applied Chemistry, except by special request.

All authors, as a matter of course, agree not to publish their accepted papers in any other publication except as hereinafter provided, and, further, they automatically agree to abide by any final decision of the Congress with respect for such paper or papers, their presentation, discussion or printing.

The Congress obligates itself to have its final Report and Proceedings, including subject and author's index, completed and ready for distribution on or before December 31st, 1912; but authors of papers received before the close of June 30th, 1912, may publish those papers in any publication they may elect after the paper is read or after the Congress has adjourned.

No paper offered to and accepted by this Congress can be at any time published elsewhere without giving credit to this Congress for such article or publication. The Congress reserves the right to reject any paper or other contribution that may be offered to it. Any paper which is of a pronounced polemical, advertising or personal character may be thereby disqualified and for that reason alone rejected, regardless of whatever merit the paper may otherwise possess.

Authors are requested to state on the papers themselves their preferences for the sections in which they wish them to be read.

Authors will *not* receive printer's proofs of their papers or abstracts.

The time consumed in reading or presenting the substance of any paper by an author or his representative at a meeting of a Section must not exceed ten (10) minutes; papers or presentations requiring more time than that must be suitably condensed so as to fulfil that requirement. Anyone reading a paper of another's authorship must be fully equipped and prepared to defend the paper in discussion, and no one else will be permitted to read such a paper; an offer to read another's paper is an implied statement to the effect of such preparation. In the absence of an author or his properly equipped representative the paper will be read by title only, and if there be any discussion it must be based upon the paper as printed, because neither the paper itself nor its abstract will be read; exceptions to this rule can be made only under regulations that may be adopted by each Sectional Executive Committee.

METHODS OF ANALYSIS AND CHEMICAL CONTROL FOR USE IN CANE SUGAR FACTORIES.*

By Guilford L. Spencer.

WEIGHTS AND MEASUREMENTS.

Weights and Measurements.—The chemist must assure himself that all weights and measures are of one system, *e.g.*, all Spanish or all English; if not, they should be reduced to one system before proceeding with the control calculations. The accuracy of all scales and the calibration of all measuring tanks should be verified by the chemist. One hundred pounds Spanish = 46·0096 kilogrms., therefore 1 lb. Sp. = 1·0143 lb. avoirdupois.

Measurement and Weight of the Juice.—Where the juice cannot be weighed, its weight must be deduced from its volume and density. Where practicable, the volume of the measuring tank should be determined by running water into it from an accurately calibrated tank. This is not usually practicable in large factories, hence the volume must usually be calculated from the averages of several measurements. An overflow pipe or other device should be provided to indicate when the tank is full.

The juice entrains a large quantity of air which increases its volume. This introduces an error for which a correction based upon experimental data must be made. The volume of air entrained varies with the temperature of the juice and also with other conditions.

In deducing the weight of the juice from its volume, the latter should be corrected for temperatures other than 17·5° C. Gerlach's table for the expansion of sugar solutions may be used for this purpose. The weight of a cubic foot of water at 17·5° C. is to be taken at 62·348 lbs., and that of the U.S. gallon, 8·3347 lbs.

Measurement of the Saturation Water.—Two tanks should be used in measuring the water, one to be filling while the other is emptying. The weight of the water is calculated from its volume. Meters are usually unsatisfactory for this purpose.

Where, through accident or other cause, the volume of the water cannot be determined, it must be estimated from the dilution of the juice by dividing the percentage of dilution by a factor approximating to 0·7. This is necessary in order to estimate the weight of the bagasse. This factor is arbitrary and varies with the quantity of saturation water and the efficiency of the milling. The necessity of using a factor should be avoided if possible.

* Abridged from "Methods of Analysis and Chemical Control for use in the Factories of the Cuban-American Sugar Company." Arranged by Guilford L. Spencer. Published by the Cuban-American Sugar Company, New York, 1911. Price $1.00.

Filter Press-Cake.—The cake should be weighed, but as this is not usually feasible, its weight may be estimated from that of several average cakes. The number of presses emptied should be recorded for use in calculating the total amount of press-cake. Where the cake is dropped into cars or carts and weighed, care must be observed to avoid including water from drip and floor washings in the weight.

Massecuites and Molasses.—Massecuites should be measured immediately they are discharged from the pans. This is necessary on account of the expansion this material undergoes in the crystallizers. These measurements are not usually necessary except preparatory to a "Run Report."

It is usually difficult to accurately measure final molasses. This is due to the air it entrains. Where the molasses is slightly reduced with water and steam to bring it to a uniform density, it may be measured before pumping it from the factory, or afterwards in the large storage tanks. Measurements of very heavy molasses in tank-cars are unsatisfactory, except where the measurement is made several hours after filling the tanks.

For control purposes, especially for the final report of the crop, the actual weight of the molasses should be reported, though, in order not to delay the reports, a small quantity may be estimated at the close of each run. The tank-cars should be tared each trip because often the buyer does not completely empty them.

Where measurements are necessarily made of heavy molasses in large tanks or tank-cars, corrections, determined by experiment, will be required for the entrained air. Heavy molasses will often entrain sufficient air to reduce its weight per gallon nearly one pound.

SAMPLING AND AVERAGING.

Preliminary Remarks.—Sampling should be so conducted that the quantity of material drawn from each tank, &c., bears the same relation to the total quantity. For example, having two equal tanks of syrup, one full, the other half full, half as much should be drawn from the one as from the other, that the subsamples when mixed may represent all the syrup. This principle should be applied in all sampling.

In averaging analytical data, each analysis should be weighted by the quantity of material it represents.

Cane.—Samples selected in the fields are usually of little value in judging the general character of the cane. This is due to the wide variations found even in a single stool. When possible the sampling should be performed at the mills and the method of analysis should be indirect, *i.e.*, the richness should be judged by analysis of the juice. A sample of juice should be drawn at the crusher or first mill for the density determination and the mixed juices should be analysed to

determine the purity, and from these two numbers the sucrose may be calculated. By exercising care, the test sample can be drawn after the juice from the cane to be sampled has washed the mills and pans.

It is convenient to have duplicate Calumet samplers, one for the regular and the other for special samples.

JUICE.—The ideal sample is one drawn continuously in proportion to the output. The Calumet automatic sampler draws a sample under approximately these conditions. This instrument resembles a vacuum-pan proof-stick, and is operated by some part of the milling machinery, preferably a mill-roll. Drawings of these samplers will be supplied to the laboratories on application to the Chief Chemist.

Where tank scales are used in weighing the juice this may be sampled by drawing a small cupful from each charge, to be composited to represent a run of definite duration, preferably a day or a watch of six hours.

The sample from the crusher or first mill is for the determination of the density, and that of the mixed juice is the basis of the factory control.

The density samples should be treated with formaldehyde or mercuric chloride, one part of either to 5000 parts juice, for preservation.

The mixed juice sample should be drawn in duplicate, one portion to be preserved with about 12 grms. Horne's dry subacetate of lead per litre and the other with either formaldehyde or mercuric chloride.

Where continuous samples cannot be obtained, small equal-measured subsamples should be drawn and composited. Only sterilized wide-mouthed jars with stoppers should be used for storage purposes. Funnels should not be used to direct the sample into the jar. The small sampling cups should be thoroughly rinsed with the juice before drawing the subsamples.

BAGASSE.—Subsamples should include all of the bagasse on one or more slats of the conductor. Composite samples, well protected from the air, may be preserved during a few hours in an atmosphere of formaldehyde, but it is advisable not to extend the storage period to more than six hours. Clean galvanized-iron cans are to be used for storing the samples. These should have a small compartment to hold cotton or a sponge saturated with formaldehyde. The slip-cover of the compartment should be perforated with a number of holes.

FILTER PRESS-CAKE.—Subsamples should be cut from a definite number of cakes in each press by means of a brass cork-borer. The small samples may be collected during a few hours without recourse to a preservative, though formaldehyde should be used. Care should be observed that the samples be drawn from representative parts of the press-cakes.

Syrup and Molasses.—Syrup and thin molasses, to be reboiled, may be sampled in the storage tanks. Heavy commercial molasses should be sampled at frequent regular intervals at the pump-tank, forming a composite sample, representing the day's work. When shipping molasses, samples should be drawn from each tank-car, to form a composite sample representing the day's shipment. Composite samples should be prepared from the daily samples, for analysis to supply the data required in the Run Reports.

Massecuites.—Massecuites are difficult to correctly sample owing to the variations in different parts of a "strike." Where this material can be sampled as it flows from the pan, small portions should be drawn from time to time to form a composite sample, but where discharge pipe lines are used this method is not feasible. In the latter case the sample should be obtained from the crystallizer or mixer, being careful to avoid including steamings and to allow time for thorough mixing.

When sampling from pans of different sizes, to form a composite sample representing a definite period for all, small conical tin measures should be used, one for each size of pan, representing the same proportional part of the material.

Sugars.—One hundred per cent. of the packages should be sampled. As the truck passes on to the scale, a spoonful of sugar should be withdrawn and thrown into a tin-lined box, provided with a small funnel or hopper-like opening. Sugar already packed should be sampled with a trier.

A composite sample, in proportion to the output of sugar, should be prepared from the daily samples for analysis for the run reports.

Miscellaneous.—The principles described apply in all sampling and averaging in the control of the factory. When practicable, composite samples of juices, massecuites, molasses, &c., should be prepared to supply data for the permanent records and daily reports, so that but a single analysis need be made daily of each class of material for these purposes.

METHODS OF ANALYSIS.

Sugar Cane.—Owing to the nature of the cane it cannot be accurately sampled without undue expense for appliances and labour. For this reason, and not on account of analytical difficulties, its analysis should be ascertained indirectly as follows: The percentage sucrose in the cane = (weight of sucrose in the raw juice + weight of sucrose in the bagasse) ÷ weight of the cane × 100.

The percentage of fibre, or marc, in the cane = percentage of fibre in bagasse × percentage of bagasse on cane ÷ 100.

The trash as well as the fibre influences the milling and fuel supply, hence it is preferable to deduce the percentage of fibre from the bagasse

tests rather than by direct analysis, being careful that only water derived from the saturation is included in the dilute juice. Direct analysis for fibre is open to the objections already stated in the paragraph on cane sampling.

JUICE.—*Brix.*—Strain the sample, through fine centrifugal lining, into a tall cylinder, letting the latter overflow. After an interval of about ten minutes insert the hydrometer, at the same time blowing the foam from the surface of the liquid. After the instrument reaches the temperature of the juice, note the graduation on its stem on a level with the surface of the juice in the cylinder, and enter this number as the observed degree Brix. The temperature of the juice should also be noted and a correction be made, if it varies from 17·5° C., by Gerlach's table.

Sucrose.—Thoroughly mix the sample juice that has been preserved with anhydrous subacetate of lead and filter a portion of it. Polarize the filtrate and calculate the percentage of sucrose, using Schmitz' table. If the Schmitz table providing for 10 percentage dilution is employed, divide the polariscope reading by 1·1.

In case mercuric chloride has been used as a preservative, the analysis may be made by Horne's dry subacetate-of-lead method, or using subacetate in solution.

The estimation of the sucrose by double polarization is described under CLERGET TESTS.

Glucose.—See GLUCOSE DETERMINATIONS.

Solids by Drying.—See METHODS OF DRYING.

Ash.—See ASH DETERMINATIONS.

BAGASSE.—*Sucrose.*—Digest 50 grms. of bagasse, reduced to small fragments, in a suitable vessel with 500 c.c. of water and 5 c.c. of a 5 percentage solution of sodium carbonate, during one hour at boiling temperature. After digestion cool and weigh the vessel and contents. Drain off a portion of the liquid, clarify it with dry subacetate of lead, and polarize, using a 400 mm. observation tube.

A tall copper beaker with a flanged lip ground to receive a metal cover is best adapted for this digestion. The cover and flange should be ground to form a tight joint, using small clamps to hold the former in position. A reflux condenser, consisting of a long straight glass tube, should be fitted in an opening in the cover. A piece of lead or copper, tared with the beaker, should be used to hold the bagasse under the water. In the absence of the special copper beaker a flask with a large neck may be used. These are inconvenient on account of breakage and the difficulty in introducing samples.

Moisture.—The moisture tests are most conveniently made in the Company's special oven (this *Jl.*, 1910, 575). This is a device for drawing heated air through the 100 grm. sample contained in a tared tube,

one end of which is closed with a perforated centrifugal sheet and the other with a removable cover of similar material. The time required for complete drying will not exceed 90 minutes at a temperature of 110° C. Several of the estates are already supplied with these ovens. In laboratories not so equipped proceed as follows:

Small shallow trays made of 80-mesh brass wire gauze are convenient for use in the moisture determinations. These should hold 80-100 grms. of bagasse and should be narrow enough for weighing on the sugar balance. The bagasse should be dried at the temperature of boiling water in a steam or water-oven, or for prompt results at 105° C., until there is no further loss of weight, or until there is a gain after a short interval, the lowest weight being accepted. The dry bagasse absorbs moisture with extreme rapidity, therefore the weighing must be quickly made.

The bagasse should be prepared for analysis by chopping it. It is not advisable to attempt to reduce it to a very fine state of division on account of the long exposure to the air that would be necessary and the consequent drying.

Residual Juice.—A sample of the juice flowing from the bagasse roll of the last mill corresponds so nearly with the residual juice that it may be accepted as such. A sample of this juice is to be drawn at the time of sampling the bagasse, and its coefficient of purity determined.

Fibre (Marc).—The fibre should be estimated by direct test, though the calculation by the indirect method should be occasionally made for checking purposes. In the direct estimation, weigh 50 grms. of bagasse into a tared metal cylinder, 3×6 inches long, the ends of which are closed, the bottom with perforated centrifugal sheet and the top with a removable cover of the same material. Place the cylinder in the syphon type of a Soxhlet extractor, and percolate first cool water and afterward hot water through the sample. Ten minute's percolation with the cool water (below 75° C.) and an additional 30 minutes with hot water is usually sufficient time to extract the soluble matter. The cylinder of the above dimensions may be used in the drying oven described above and the drying of the dripping-wet material may be accomplished in about four hours or less time. In the absence of the special oven the drying may be conducted in a vacuum or ordinary oven. The dry fibre should be cooled in a desiccator and be quickly weighed, since it absorbs moisture from the air with great rapidity.

The calculation by the indirect method is made as follows. Percentage of sucrose in bagasse $\div$ coefficient of purity of residual juice $\times$ 100 $=$ per centage of juice solids in bagasse; 100 $-$ (percentage of moisture in $+$ percentage of juice solids) $=$ per cent. of fibre.

Filter Press Cake.—*Sucrose.*—Reduce the sample to a fine state of division. This is readily accomplished, provided the press work is satisfactory, by cutting the sample in a large mortar with scissors. The scissors should be held with a handle in each hand.

Rub 50 grms. of the press-cake in a mortar to a cream with water and wash it into a 200 c.c. flask. Add sufficient subacetate of lead to clarify the solution and dilute it to the mark with water. Shake the flask and contents very thoroughly and filter. Polarize the filtrate, using a 200 mm. tube. The polariscope reading is the percentage of sucrose in the sample.

The following is a convenient method of compositing filter-cake samples:—Rub 25 grms. of the six-hour sample to a cream in a mortar with water and 6 c.c. subacetate of lead and set this aside until the next six-hour sample is ready. Add 25 grms. of the second sample and 6 c.c. subacetate to the previous sample and again rub to a cream. Continue in this way until the fourth sample has been added and then wash the contents of the mortar into a 200 c.c. flask and proceed with the analysis as already described.

Moisture.—Dry 5 grms. as directed under Methods of Drying.

Sugars.—*Sucrose.*—Wash 26·048 grms. of the sugar from the weighing capsule with water into a narrow-necked flask. Dissolve the crystals, then add sufficient subacetate of lead solution to effect the clarification; mix the contents of the flask by a rotary motion; add about 5 c.c. of alumina cream, and dilute the mixture to 100 c.c. Mix thoroughly and pour the contents of the flask on to a filter, covering the funnel to prevent evaporation. Reject the first portion of the filtrate, which is diluted with the moisture of the filter-paper. Polarize the filtrate, using a 200 mm. tube.

Only the most accurate flasks in the laboratory should be used in the sugar tests. The polariscope should be checked with the standard quartz plate before polarizing the sugar.

For the double polarizations see Clerget Tests.

Glucose.—See Glucose Determinations.

Ash.—See Ash Determinations.

Moisture.—See Methods of Drying.

Massecuites and Molasses.—*Brix.*—Dissolve a definite weight of the material in an equal weight of water and determine the corrected degree Brix of the solution; multiply this number by 2 to obtain the degree Brix of the material. It is very important that the sample be thoroughly mixed and that all crystals be dissolved.

Sucrose, Direct Polarization.—Wash the normal weight of the solution used in the Brix determination (=0·5 normal weight of the original material) into a 100 c.c. flask; add sufficient subacetate

solution to secure a good clarification, complete the volume to 100 c.c. with water, mix thoroughly, and filter. Measure 50 c.c. of the filtrate in a 50 to 55 c.c. flask and add sufficient diluted acetic acid to acidulate the solution, then fill the flask to the 55 c.c. mark with water. This solution is usually light enough coloured to polarize in a 200 m.m. tube. If the colour is too dark filter the solution through powdered bone-black, rejecting the first half of the filtrate. If preferred, about 0·5 grm. of powdered dry bone-black may be shaken with the solution in the flask to decolourize it. Should the solution still be too dark to polarize in a 200 m.m. tube, use the half-length tube. The polariscope reading must be increased by one-tenth to compensate for the dilution, and the polarization multiplied by 2 to bring it to terms of the original material.

Solutions of first massecuites may usually be clarified with normal acetate of lead solution, thus obviating the acidulation with acetic acid before polarizing.

In the control of the pan boiling a convenient and sufficiently accurate method of analysis is as follows:—Reduce the material to approximately 20° Brix with hot water; cool the solution by passing it through a coil of $\frac{3}{8}$ in. tin tubing immersed in a stream of cold water; determine the Brix of the solution and measure the quantity corresponding to it with a sucrose pipette into a flask and proceed as usual with the analysis, and calculate the purity. If an approximate Brix of the original material is required, determine the sucrose in it and from the two sucrose numbers and the Brix of the dilute solution calculate the Brix of the original material. It must be considered that analysis of dilute solutions give lower purities and higher Brix values than by the usual method. This is immaterial in pan control provided one method is used for all these tests that the data may be comparable. In a factory that has been using the usual method a few comparative tests should be made that the superintendent may note the differences by the two methods and take them into account.

For the method by double polarization see CLERGET TESTS.

Glucose.—These tests are not often required in massecuites. For procedure see GLUCOSE DETERMINATIONS.

Ash.—See ASH DETERMINATIONS.

Moisture.—See METHODS OF DRYING.

CONDENSATION AND WASTE WATERS.—Frequent sucrose tests should be made in water from the condensers and tail-pipes. In very exceptional cases the water may contain sufficient sucrose for a polariscopic test. The sucrose content is usually very small and may be estimated with sufficient accuracy by the α-naphthol test. This test is made as follows:—Add 5 drops of a 20 per cent. solution of α-naphthol in alcohol to 2 c.c. of the water in a test-tube, then add

10 c.c. of concentrated sulphuric acid, using a pipette to conduct the acid to the bottom of the tube. If sucrose is present a violet zone forms between the two liquids; in the presence of 0·1 per cent. of sucrose the reaction is obscured by the darkening of the solution; with 0·01 per cent. of sucrose the colour zone is that of a very dark-red wine; with 0·001 per cent. of sucrose the entire solution is coloured. Impure water will sometimes impart a faint colour in the above test in the absence of sucrose, but this is usually readily distinguished from the colour produced by sugar.

A very thorough control of the boiler-feed water should be made by means of the α-naphthol test and very frequent samples. If sugar is discovered in the water, the engineer must be immediately advised and tests of the water from each tail-pipe must be made to locate the source of the sugar.

Clerget Tests.—*Molasses Samples.*—In making these tests, comply strictly with the directions given.

The *direct polarization* is to be made as described under Massecuites and Molasses. The temperature of the polarization should be noted and when practicable should be near 20° C. The solutions should be prepared at the temperature of the polarization.

The *invert polarization* should be made at the temperature of the direct, using a water-jacketed tube for the purpose. The use of this tube is also necessary in the direct polarization.

It is advisable to dissolve 2·5 normal sugar weights of the molasses in 500 c.c. in making up the solution for the direct polarization, to ensure sufficient material for preparing the invert solution.

Remove nearly all the lead from the solution prepared for the direct polarization, using a strong solution of potassium oxalate as the precipitant, and adding a little alumina cream, increasing the volume of the molasses solution 10 per cent. Measure 75 c.c. of the deleaded solution into a 100 c.c. flask, add to it 5 c.c. of hydrochloric acid, containing 38·8 percentage of the acid, and mix the contents of the flask by a circular motion. Place the flask in a water-bath heated to 70° C. and raise the temperature of the sugar solution to 67-69° C. in two and a half to three minutes, and maintain this temperature until the total heating period reaches ten minutes. Remove the flask and place it in cold water, so as quickly to reduce its temperature.

A thermometer should be placed in the sugar solution during the inversion.

The deleading, without dilution, may be accomplished with anhydrous sodium carbonate in quantity a little short of sufficient for the precipitation of all the lead. The writer has experimented with sodium oxalate for deleading with promising results.

The inversion may be conducted at room temperature if preferred. After the addition of the acid, set the flask aside in the laboratory for twenty-four hours, then prepare the solution for analysis.

After the inversion wash the sugar from the thermometer into the flask. Cool the solution to the temperature at which the direct polarization was made, and fill the flask with water to the mark. If this solution is very dark, filter small portions at a time through powdered bone-black, rejecting the first half of the filtrate, or shake it with one grm. of dry bone-black in a fine powder; filter and polarize the solution. The omission of the bone-black and the addition of about a grm. of metallic zinc dust to the solution, or the use of both, usually produces a satisfactory solution for polarization.

Several readings should be made and their average and the temperature of the solution in the tube be noted. With a sensitive polariscope it is usually easy to make these observations accurately to 0·05° on the cane sugar scale. Great care is essential both in the matter of observation and temperature, as there is no analytical work in the sugar laboratory more liable to personal error than in the invert polarizations. The errors of observation are multiplied in the calculations.

The following formula is to be used in making the calculations:—

$$\text{Percentage of sucrose (Clerget)} = \frac{100S}{142{\cdot}66 - \dfrac{t^\circ}{2}},$$

in which S (in sugar-house products) is the arithmetic sum of the direct and invert readings. The constant must be changed according to the concentration of the invert sugar solution. A knowledge of the approximate sucrose and glucose content of the material in terms of invert sugar is necessary in order to select the constant to be used. The table of constants to be used will be found in "Cane Sugar," by Noël Deerr, page 454.

In the analysis of a sugar the half-normal weight of the material should be contained in 75 c.c. of solution for inversion.

The Company's Run Reports require the determination of the sucrose by the Clerget method in the juice, sugars, and final molasses. In the case of the juice, Clerget tests should be made at frequent intervals of composite samples of the mixed juices preserved with mercuric chloride, using normal acetate of lead for clarifying. Or the lead may be used and afterward precipitated with potassium oxalate. This procedure is advisable on account of the precipitation of dextrose and levulose by the basic lead salt. These analyses are for use in estimating the Clerget test of the average juice for the Run.

If these tests indicate a certain increase or decrease in the sucrose as compared with the direct polarization, the same percentage of change is to be applied to the average polarization of the raw juice to estimate its Clerget number.

The sucrose need be determined but once by Clerget's method during each run in sugars and final molasses, using the composite sample for this purpose.

GLUCOSE DETERMINATIONS.—*Soxhlet's Copper Solution.*—(*A*) Dissolve 69·28 grms. copper sulphate in water and dilute the solution to 1000 c.c. (*B*) Dissolve 346 grms. sodium and potassium tartrate (Rochelle salt) in about 600 c.c. water; add 200 c.c. of a solution of sodium hydrate containing 500 grms. per litre, and complete the volume to 1000 c.c. with water.

Solutions *A* and *B* are to be kept in separate bottles and equal parts are to be mixed when making the tests.

Method No. 1.—For materials containing 1 per cent. or less of glucose. Dissolve 50 grms. of the material in water in a 250 c.c. flask and add sufficient of a saturated solution of normal lead acetate for clarification; complete the volume to 250 c.c., mix thoroughly and filter. To the filtrate add anhydrous sodium carbonate in small portions and in slight excess to precipitate the lead and again filter.

Measure 25 c.c. each of Soxhlet's solutions *A* and *B* into a beaker and add 50 c.c. of the sugar solution prepared as above. Heat the contents of the beaker slowly to the boiling-point (4 mins.) and continue the heating two minutes at this temperature. A 400 c.c. beaker is a convenient size for this test, and the size adopted should be used in all glucose work, since varying the area of the liquid influences the reduction. When the heating is concluded, remove the beaker from the fire and add 100 c.c. cold recently boiled distilled water to its contents and immediately collect the precipitate upon a tared Gooch filter and wash it thoroughly with hot water. The asbestos felt in the Gooch crucible should be very thick. Examine the filtrate for cuprous oxide and asbestos and if either is present again pass the solution through the filter. Follow the wash water with 2 or 3 c.c. strong alcohol and this with a few drops of ether. Place the crucible in an oven and dry the precipitate about thirty minutes, then cool it in a desiccator and weigh it. Ascertain the percentage of glucose by the following table, based upon that of Herzfeld. This table assumes a concentration of 20 grms. of the material in 100 c.c. and gives percentages directly:—

GLUCOSE TABLE.

Cuprous Oxide.	Glucose.	Cuprous Oxide.	Glucose.	Cuprous Oxide.	Glucose.	Cuprous Oxide.	Glucose.
mgrms.	Per cent.	mgrms.	Per cent.	mgrms.	Per cent.	mgrms.	Per cent.
56	0·05	112	0·30	169	0·56	225	0·85
62	0·07	118	0·32	175	0·59	231	0·88
68	0·09	123	0·35	180	0·62	237	0·90
73	0·11	129	0·38	186	0·65	242	0·93
79	0·14	135	0·40	191	0·68	247	0·96
84	0·16	141	0·43	197	0·71	253	0·99
90	0·19	147	0·45	203	0·74	259	1·02
95	0·21	152	0·48	208	0·76	265	1·05
101	0·24	158	0·51	214	0·79	270	1·07
107	0·27	163	0·53	220	0·82	276	1·10

Method No. 2.—For materials containing 1 per cent. of glucose. Prepare a solution of the material as in method No. 1. Into a series of test-tubes transfer 1, 2, 3, 4 and 5, c.c. of the sugar solution and add to each 5 c.c. of the mixed Soxhlet's solution, and heat to boiling. Let the cuprous oxide subside or filter it off and note the colour of the solutions in the tubes. Transfer 40 times the volume of the sugar solution that was used in the tube that shows the lightest but still very distinctly blue colour, to a 200 c.c. flask and fill it to the mark with water. These preliminary tests are usually only necessary at the beginning of the season. The strength of the solution may be gradually increased as the glucose decreases with the ripening of the cane. Proceed with the analysis and collect the cuprous oxide as in method No. 1. Multiply the weight of cuprous oxide by the factor 0·888 to ascertain the corresponding weight of metallic copper. In analyzing molasses, heat the Gooch crucible 15 to 20 minutes to redness to convert the cuprous into cupric oxide. Weigh the oxide quickly as it is very hygroscopic. Multiply the weight of cupric oxide by the factor ·8 to reduce it to terms of metallic copper. This treatment is necessary in analyzing molasses, since the cuprous oxide carries down impurities with it. Make the calculations by the formulas and table of Meissl and Hiller as follows:—

Let Cu $=$ mgrms. of copper reduced; $P =$ polarization of the material; $W =$ weight of the material in 50 c.c. of the solution; $F =$ factor from the table of Meissl and Hiller; $\text{Cu} \div 2 = Z$, the approximate weight of glucose; $100\ Z \div W =$ approximate per centage of glucose $= y$; $100\ P \div (P + y) = R$, relative number for sucrose; $100 - \text{R} = I$, relative number for glucose; $\text{Cu} \times F \div W =$ percentage of glucose in the material.

Meissl and Hiller's Factors for Glucose.

$R : I$	Approximate Absolute Weight of Glucose = Z.						
	0·200	0·175	0·150	0·125	0·100	0·075	0·050
	Factors	Factors	Factors	Factors	Factors	Factors	Factors
0 : 10	56·4	55·4	54·5	53·8	53·2	53·0	53·0
10 : 90	56·3	55·3	54·4	53·8	53·2	52·9	52·9
20 : 80	56·2	55·2	54·3	53·7	53·2	52·7	52·7
30 : 70	56·1	55·1	54·2	53·7	53·2	52·6	52·6
40 : 60	55·9	95·0	54·1	53·6	53·1	52·5	52·4
50 : 50	55·7	54·9	54·0	53·5	53·1	52·3	52·2
60 : 40	55·6	54·7	53·8	53·2	52·8	52·1	51·9
70 : 30	55·5	54·5	53·5	52·9	52 5	51·9	51·6
80 : 20	55·4	54·3	53·3	52·7	52·2	51·7	51·3
90 : 10	54·6	53·6	53·1	52·6	52·1	51·6	51·2
91 : 9	54·1	53·6	52·6	52·1	51·6	51·2	50·7
92 : 8	53·6	53·1	52·1	51·6	51·2	50·7	50·3
93 : 7	53·6	53·1	52·1	51·2	50·7	50·3	49·8
94 : 6	53·1	52·6	51·6	50·7	50·3	49·8	48·9
95 : 5	52·6	52·1	51·2	50·3	49·4	48·9	48·5
96 : 4	52·1	51·2	50·7	49·8	48·9	47·7	46·9
97 : 3	50·7	50·3	49·8	48·9	47·7	46·2	45·1
98 : 2	49·9	48·9	48·5	47·3	45·8	43·3	40·0
99 : 1	47·7	47·3	46·5	45·1	43·3	41·2	38·1

Ash Determinations.—The sulphate method is to be used in all ash determinations. In this method the material contained in a shallow platinum dish is saturated with pure sulphuric acid, then gently heated until intumescence ceases. The heat is now to be gradually increased and the carbon burned. A muffle heated to dull redness is the best device for ashing sugar products. Care must be exercised not to fuse the ash. The sulphuric acid must be in sufficient quantity to convert the mineral constituents of the material into sulphates. To reduce the sulphated ash to terms of the normal ash, deduct one-tenth of its weight.

The following approximate quantities of the sugar products and sulphuric acid should be used in each test:—2 grms. sugar and 0·5 c.c. acid; 10 grms. juice and 1 c.c. acid; 2 grms. molasses and 1 c.c. of acid.

Methods of Drying.—The drying of sugar-house products is not a simple problem, and it is difficult to determine the proper moment at which to discontinue the operation.

A suitable method of drying bagasse samples has been described under the analysis of this material. Juice, filter-cake, sugar and molasses should be dried to constant weight in a vacuum oven. Shallow dishes should be used. The lead caps for bottles, 3 in. size, are well adapted for this purpose. In the absence of a vacuum oven the analysis must be conducted in an ordinary oven, the temperature varying with the material, but should not exceed 100° C. Decomposition of many materials occurs in the ordinary oven, so considerable judgment and experience are required to determine the proper length of the heating period. Vacuum ovens that are heated by steam may conduct the drying at a higher temperature than the thermometer in the oven indicates owing to the conductivity of the shelves. Small vacuum-distilling apparatus consisting of a flanged porcelain vessel and glass dome connected with the vacuum system and heated by boiling water give good results. The dishes must rest upon the bottom of the porcelain vessel.

(To be continued.)

RUSSIAN SUGAR NOTES.

The last three months have served to join the Russian sugar campaigns—1910-11 and 1911-12 together; and although the new campaign dating from 1-14 September is well on its way, the position is about as puzzling as it can be. Briefly recapitulated it is as follows: A great beetroot harvest came on the top of a season of comparative scarcity (largely caused by speculation) in 1910, and so menaced the inland market with a glut as to force the refiners to reconstitute the dissolved syndicate. Encouraged by the success of the preceding year sugar planters sowed much larger areas this year, threatening to intensify the already difficult situation caused by the 1910-11 large production. But a dry, withering summer all over Europe has greatly modified the outlook. It has injured the beetroot crops of Germany and Austria so seriously as to raise high hopes amongst the Russian producers that these two countries will be compelled to buy sugar from them. The idea that the convention markets might be open wider to Russian sugar has formed the subject of frequent observations in the Russian press for some months, and the announcement of a proposed conference on the subject indicates a probability that the idea was not wholly irresponsible talk; but had official encouragement from the first.

Another suggestion for the prompt relief of the Russian market was the concession to sell to the convention markets as much sugar as would be required to fill up the difference between the quantities it had a right to sell them under the convention and the limited extent to which it had taken advantage of that right. Finally, the

idea already made known in connection with the problem of widened markets may be mentioned again, viz., the sale of sugar in the Government drink shops that are spread over the country in so many thousands.

The tendency of prices during the past three months has been very uncertain. When the refiners became re-syndicated they fixed a minimum price. But the market did not respond. It sagged, but not seriously; still they remained firm. At length, as the bad weather told more and more on Russian cereals and reports of disaster to the Austrian and German beetroot became confirmed, the market hardened especially for export goods, Odessa quotations being particularly firm for export warrants. Even here, however, the market has not held up. Prices are down at the port, and export crude sugar is quoted 2 roubles 45 copecks per pood. Kieff prices at same date are 4 roubles 85 copecks per pood, and lump sugar 5 roubles 15 copecks. New campaign sugar crude has been sold at 3 roubles 93 copecks per pood, September and October delivery. The inland prices include the excise of 1 rouble 75 copecks per pood.

The recent history of the sugar trade has been such as to encourage the continued construction of new sugar works, and the more frequent introductions of modern machinery and apparatus into others which are being enlarged to deal with the increased business that is anticipated. New factories are under construction and projected for the Kieff Government, the Kalics Government, and in Ekaterinoslaff where the first sugar factory on the Lower Dnieper is to be built. An interesting development of the industry is the introduction into the Kapustyansky and Gorodoksky factories of the Podolia Government of the Huillard process of drying the expressed sugar pulp. The process has proved to be a success. Up till now, this by-product was troublesome to keep for cattle food: but it keeps excellently in a dry state; and it has been found possible to export it profitably. As the application of the process has worked out successfully, it is expected that it will be introduced into the remaining factories of Russia: particularly those that are located near to the western frontier. A further though unexpected development is the accentuation of the movement of concentration of the sugar industry into fewer hands. It is becoming largely syndicated either by the absorption of several mills into one house, or the formation of joint stock companies to embrace a number of works.

The production of sugar in the 275 raw, and raw and refined, sugar factories between 1st and 14th September, 1910, and 1st to 14th August last is given by the Indirect Taxes Department as 106,587,987 poods raw and 18,207,919 poods refined: and the quantity put on the market, *i.e.*, delivered, was 80,458,482 poods and 16,922,950 poods respectively. The 21 sugar refineries produced during the same

period 34,034,692 poods, and these put on the market 29,566,927 poods.

Far Eastern Russia as well as Manchuria is receiving the attention of sugar industrialists. A large sugar mill is projected for the district of Ussurisk, where a company is being formed with abundant capital on behalf of which a great extent of land has been applied for, on which to grow beetroot and build a factory. Expert advice pronounces the ground quite suitable for beet; and if this be the case, the question is just one of capital, initiative and technical skill coupled with industry. Manchuria and the Amur have both had to call in foreign sugar to satisfy their wants; the market therefore appears to be ready made for the new factories built and projected in these provinces.

The beetroot harvest this year will be much larger than that of last year in point of quantity; but the sugar content on the other hand shows a decline on the whole, according to latest estimates.

THE ITALIAN SUGAR INDUSTRY.

(Translated from *die Deutsche Zuckerindustrie.*)

Among those Italian sugar industries that have shown considerable expansion during the last three decades, that dealing with sugar has been by no means the least noteworthy. As proof of its development we need only point to the fact that, to cover home requirements in 1910, only 6,500 metric tons of sugar had to be imported, whereas in the year 1898-99 the imports amounted to 73,537 tons. According to a Report recently issued by the Italian Ministry of Agriculture and Commerce the production of beet sugar was down to 1888 only undertaken experimentally, while during the last campaign in Italy there were at work 29 raw sugar factories, six sugar factories with refineries attached, and three refineries. The majority of these lie in the lower Po valley where the cultivation of beets is widespread. On the left bank of the Po there are sugar factories in Ostiglia, Ficarolo-Po, Legnago, Lendinara, Cologna, Venice, San Bonifacio, Vicenza, Cavanella-Po, and San Vito al Tagliamento; between the left bank and the Apennines there are sugar factories in some fifteen different towns. Further factories are found in Granaiolo and Montepulciano, in Tuscany and in Foligno, Rieti, and Naples; the factories possessing refining plant are situated in Pontelongo, Pontelagoscura, Ferrara, Bologna, Senigallia, and Avezzanc, while the pure refineries are to be found in Ferrara, Sampierdarena, and Ancona.

The Italian sugar industry is entirely in the hands of joint stock companies which partly own several of the factories and partly have formed themselves into groups. Nearly all these groups belong to

the *Unione Zuccheri*, or Sugar Association, which dictates the price of sugar and thereby puts a check on any competition between individual factories.

The centre of the industry is Ferrara, but the seat of the trade is in Genoa where most of the firms have offices. By far the most important of the Groups is the Societa Ligure Lombarda per la Raffinazione degli Zuccheri, which has its headquarters in Genoa and possesses a working capital of 24 million lire (£950,000). To it belong the factories in Parma, Montepulciano, Cologno, Venice, San Bonifacio, the factory and refinery in Senegallia, as well as the factory and distillery in Sampierdarena near Genoa, where there is also a jute mill to provide the necessary sacks. This company also owns the sugar factory "Ligure Vicentina" in Vicenza and "Ligure Sanvitese" in San Vito al Tagliamento and is financially interested in several other groups including the Societa Ligure Ravennate.

Another noteworthy company in the Italian sugar trade is the Societa per l'Industria dello Zucchero Indigeno, which is established in Rome. This company has a capital of 18 million lire (£682,500) and was formed by the amalgamation of two older societies belonging to Genoa and Rome. The new undertaking is kept in close commercial touch with Genoa, and controls the factories in Granaiolo, Bologna, Bazzano, Cesena, Legnago, Rieti, and Savigliano. In close relation with it is the factory at Lendinara, which belongs almost entirely to Deputy Mairani and has its head office at Rome, under the title of Fabbrica Lendinatrese E. Mairani & Co.

A third group is the Societa Industriale Anonima Eridania, with its seat in Genoa; this company has a share capital of seven million lire and owns the factories in Forli and Codigoro. With it are combined the Zuccherificio Agricola Ferrarese (capital two million lire), situated in Ferrara, where their factory is; and the "Raffineria Ferrarese," which possesses a capital of over five million lire and owns as well a factory in Pontelagoscura.

Genoa is also the headquarters of the "Zuccheria Nationale" (capital six million lire), which runs a factory in Ficarolo. This company has absorbed the Company "Adria" in Liquidation, another Ferrara concern, which had a factory and distillery in Cavanella; and also the Societa Zuccherificio Agricola Piacentino in Piacenza, which had a factory in Mortizza.

The Societa Romana per la Fabricazione dello Zucchero in Rome, possessing a capital of 10 million lire, has two important sugar factories and refineries in Avezzano and Pontelagoscura.

The last group, the "Gulinelli," consists of the "Societa Zuccherificio e Distilleria Alcool Galinelli" with a capital of 10 million lire, headquarters at Ferrara and factories at Pontelagoscura and Massalombarda; and the smaller Societa Agricola Lamone in Ferrara, which has a factory at Mezzano.

The remaining sugar factories have joined themselves to one or other of the above groups; there are at least a dozen of some importtance.

The capital invested in the Italian sugar industries will thus be seen to be very considerable; it is estimated at about 125 million lire.

The industry at first only developed very slowly. As, however, it was protected from outside competition by a strong import duty, it soon began to exert itself and has risen in a few decades to its present flourishing condition. Owing to the heavy fiscal burdens imposed by the manufacturing tax, out of which the Italian Government pockets annually 100 million lire (£3,958,333), the industry has stood in need of substantial capitalization. This in view of the crisis in agriculture was not easy to obtain; hence it happens that the industry is almost entirely in the hands of the banks and of sundry capitalists. Till 1910 not a single factory had arisen anywhere in Italy which had been financed from the start by agriculturists. But that year saw beet growers and sugar dealers combine to erect a sugar factory at Cento, which will start its campaign next year.

Other factories are promised this Autumn in Venetia. The plant is *in situ* and will commence operations at the beginning of the campaign. Yet if it is to be a question of factories obtaining their entire product from an area yielding poor sugar beets, then the sugar industry of Italy has not a bright outlook before it. For if the sugar consumption which at present stands at 10·6 lbs. per head of population tends to increase, the sugar factories with their increasing fiscal burdens cannot count on any appreciable expansion in their output.

Warnings against the proposed erection of new factories in Venetia have repeatedly appeared in the press, and no less a person than the late Prime Minister, Luzzatti, pointed out two years ago the danger of any further extension of factories in that district.

A reduction in the manufacturing duty and in the excise duty would lead to an improvement in sugar prices, but also, it is to be feared, to swamping of the Italian market with foreign sugar, a contingency which the industry much dreads. However, as the Official Report puts it, an attempt might be made to reduce by slow instalments the manufacturing duty and, by the granting of export bounties, open up channels for the sugar industry, which at present owing to the existing fiscal system are closed to it.

Italian agriculture has certainly derived great industrial advantages from the cultivation of sugar beets, but has not always met the demands of the sugar factories, so that these have many a time been obliged to remove to more favourable neighbourhoods. The area planted with sugar beets amounts to about 50,000 hectares (123,500 acres) and the average yield is 30 metric tons of roots per hectare (12 tons to the acre). In the neighbourhood of Ravenna as much as 50 metric tons has been obtained, while other localities have had to be

content with 18 metric tons. The beets have an average yield of sugar of 14 per cent. The best varieties occur in the Fucino district, while in Venetia only poor roots are produced. The price for 100 kg. roots varies between 2½ and 3 lire (2s. to 2s. 4½d. per 220 lbs.).

Sowing begins in Italy in March, and the harvest takes place in July. The seed is almost entirely derived from foreign sources but of late attempts have been made to obtain seeds from Italian mother beets. It is reported that as a consequence of the new sugar laws a sugar experimental station will shortly be established in Rovigo.

According to trustworthy information, the Italian sugar industry produced in the year 1909-10 campaign from a crop of 1,000,000 tons of roots 110,795 tons of sugar. The yield of 1910 in consequence of a good harvest of 1,550,000 tons of roots is expected to give correspondingly good results.

RÔLE AND USE OF SULPHUROUS ACID IN CANE SUGAR FACTORIES.*

By L. GIRAUD, Mauritius.

The colouring matter in cane juice is derived: (1) From the rind of certain canes that on milling yield to the juice a violet or red colouring body, easily recognizable when red or black canes are crushed in a small laboratory mill, and also in the factory. (2) From a colouring substance of the bagasse which appears to exist in all canes, and is characterized by the green coloration that the bagasse assumes when it is treated by lime or other alkalis. The small particles passing through the sieve yield this colouring matter to the juice during defecation, and often give the defecated juice a bright olive-green colour. (3) A red or brown body, produced by contact with air on the soft parts of the cane by oxidizing enzymes, analogous to those forming when a sugar beet is cut open. Raciborski, in 1898, pointed out two of these oxydases, one of which is destroyed at 60° and the other at 95° C. This colouring matter is found in the tissues of the cane attacked by cryptogam parasites. It often passes into the *usine* in the red pieces, or else with the deep "sores," in which the diseased tissues are red or brown. (4) From the red or brown colouring bodies derived from the destruction of the glucose in the hot alkaline juice, which is met with in defecated juice. (5) From the colouring substances resembling caramel forming during evaporation in the triple effect, and especially during concentration *in vacuo*. (6) By the contact of the acid juices or acid massecuites in iron tanks,

* Paper read before the *Société des Chimistes de Maurice*, and published in the *Bulletin* (*Mauritius*).

piping, or wagons, which has the effect of blackening the products by the production of iron compounds.

Sulphurous acid in the green juice should destroy the colouring matters from the rind, as in wine manufacture it decolorizes red wine, transforming it into white. By its reducing action it should prevent coloration by oxydases in the presence of air.

If only the white or pink pieces of cane are crushed in a laboratory mill, a juice is obtained containing oxydases, and this gives on defecation a juice of a very dark colour, brownish black, in fact.

The principal decolorizing action of sulphurous acid in cane as in beet sugar factories consists especially in the sulphites, which accompany the sugar from the juice to the pans, and oppose their reducing effect to the oxidizing and colouring action of the air and of the oxydases.

This reducing action proceeds in the absence of air during concentration in the triple effect and in the vacuum, and is evidenced by an oxidation of the sulphites to sulphates, which may amount to 50 per cent. of the sulphurous acid used, according to Fouquet. Heat being one of the causes of coloration, it is especially in its presence that this oxidation of the sulphites is manifested.

The alkali hydrosulphites, still more eager for oxygen, produce a more intense decoloration. By absorbing oxygen from the air, the sulphited juice re-colours. Juice defecated by "Blankit," placed in a glass dish, is coloured brown in that portion exposed to air.

In making white sugar it is therefore of importance that the nucleus of crystals should be formed in a decolorized medium, and in absence of air, which is the case when boiling *in vacuo*.

From a recent article by our colleague, Mr. Prinsen Geerligs (this *Jl.*, 1910, 285), we learn that in Java the white sugar for Bombay is made by first liming the juice and afterwards sulphiting it to neutrality to phenolphthalein. This indicates that the rôle of the sulphurous acid as a free acid is trifling in the green juice, and this has also been found to be the case for beet sugar factories.

It is probable that sulphurous acid exerts its reducing action on other bodies than the colouring matters. It is thought that it may combine with the glucose in its quality of an aldehyde. This question demands study in cane factories, in which there are generally large quantities of glucose. It is of interest to know if these glucose-sulphurous acid compounds remain through defecation or are decomposed during evaporation.

The free sulphurous acid found in the condensed water of the evaporating apparatus may come from this source, which does not exist in beet factories, where the condensed water is rather alkaline than otherwise.

The manufacturers of Mauritius who use this water for feeding their boilers have found that the volatilized sulphurous acid very rapidly destroys the fittings of the plant.

The study of the rôle of sulphurous acid may appear to be only of theoretical importance. In reality, from the practical point of view, it is concerned with ascertaining whether sulphurous acid used in the free state has such an influence during manufacture that it is unnecessary to endeavour to return to the employ of sulphites, pure and simple, as was formerly done in Mauritius. In our factories, the use of gaseous sulphurous acid has a number of inconveniences, which may be enumerated thus: (1) The loss of at least half the sulphur burnt. (2) The sheet-iron roofing of the factories is rapidly attacked by the free acid. (3) The necessity of special apparatus, of which some, the Giffard injector for example, are not without disadvantages. (4) The sulphurous acid in the air must be harmful to the vegetation of the cane in the neighbourhood of the factory.

Unfortunately for us the shipping companies refuse to transport liquid sulphurous acid, of which our European colleagues have been able to appreciate the value and advantages, which would appear to be greater than in the case of sulphurous acid produced directly by combustion in air.

ABSTRACTS, SCIENTIFIC AND TECHNICAL.*

Cross Pollination of the Sugar Cane. *By G. Wilbrink and F. Ledeboer. Mede. Proefs. Java-Suikerind., No. 6;* through *Agric. News, 1911, 10, 227.*

In this very interesting article it is pointed out that the flowers of the sugar cane require moisture to enable them to open, and that arrows that are at all dried up will not flower. Flowering commences when the arrow is pushed out of the sheath, an event which may occur early in the season, or later, according to circumstances. The flowers themselves commence to open early in the morning, even before sunrise, and, in Java, continue to do so until about 8 a.m. It has been noticed that the first arrows to open are the stronger ones, while the first flowers produced on the arrow are also the most vigorous. As is now well known, certain varieties of the sugar cane produce little, if any, fertile pollen, though abortion of the female organs is rare. The pollen itself consists of small yellow balls, each of which has a thick outer wall of a corky consistency and a thin inner membrane. There is an aperture in the outer wall through which the pollen tube is extruded on germination. Healthy pollen grains contain starch, a fact which is made use of in testing their fertility

in the following manner: A nearly ripe anther is opened with a needle in a solution of iodine in potassium iodide; the iodine imparts a blue colour to the starch in the pollen, if it is present; if starch be not present, the pollen is infertile. By this means, after testing the pollen in several anthers, it is possible to determine if any given variety of the cane possesses fertile pollen. Three methods for securing cross-pollination are described, in all of which a variety producing practically no fertile pollen is used as the female parent. (1) According to the first method, the two varieties to be crossed are planted in alternate rows, and arrows of the male variety are bent over, so that each occupies a position a little above, and to windward of, an arrow of the female variety. Bent sticks are tied below the growing joints of the male arrows, to prevent their breaking by lengthening. Furthermore, the male arrows are cut soon after they have been used, in order to preclude the contamination of the female arrows through seeds from the male arrows being blown into them. This natural method of crossing is simple, and gives rise to many seeds, but it can only be employed with varieties producing numerous flowers. (2) The second method employed is as follows: Male arrows are cut two or three days after they have commenced to flower, and are placed in a bamboo joint filled with water. The cutting takes place before sunrise, and one or two joints of the top of the cane are left attached to the arrows, in order that they may remain fresh for about two days. The bamboo pot is then tied to the female arrow in such a way that the male is above the female, and on the windward side. This operation is conducted when a few flowers at the top of the female arrow are open, as it is then certain that several will be open on the succeeding morning; it must be performed before the sun has any power. When much of this work has to be done, it is commenced in the late afternoon, or better, in the evening. (3) A third method for securing cross-pollination is to collect the pollen on a glossy paper, and subsequently to convey it to the stigma of the female flowers by means of a soft brush. In order to obtain the pollen, the male arrow is bent down, on one evening, and on the next morning, as soon as it is dry, the arrow is well shaken over a piece of paper, from which the pollen is transferred to a small box, or a watch glass, lined with a fresh piece of leaf, or a moist piece of filter paper. This method, however, has not proved very successful. After having described these three methods of effecting cross-pollination, the authors point out that when it is desired that the parentage of the seedlings shall be known with certainty, it is necessary to surround the female arrow with a screen. This is because the pollen is often carried a long distance by the wind. For the purpose, a special form of apparatus is employed, in Java, having an opening on the lee side, provided with a double over-lapping cover. The male arrow is introduced through this opening, preferably when there is no wind. It is

interesting to note that some varieties do not give a good yield when fertilized within a screen. The best method of collecting the seed has been found to be to surround the female arrow with a small muslin bag in which the seeds are allowed to ripen—a process occupying from two to three weeks. The seeds are allowed to dry for one to two days in the bag; afterwards all the ears are stripped from the arrow and sown at once in pans. These are 24 in. wide and 16 in. deep; they are half filled with rich mould, on the top of which is placed a mixture of dry sifted horse-dung and fine sand in equal quantities, forming a layer 6 in. deep. All the seeds arising from one arrow are sown in one pan, unless they are too numerous, when two or three pans are used. The seeds are pressed down on wet sand, but are not covered; they are carefully watered in the morning and evening, and are protected with a loose covering of trash when a shower is expected. They are exposed to full sunlight from the first. If there are no results at the end of fourteen days, it is certain that no fertile seeds have been produced on the arrow. In cases of success, the young plants are planted out when 8 in. high, in pots 10 in. deep by 5 in. wide, filled with mould. One month later they are transplanted into the ground, being removed from the pot with the mould. If they are planted directly in the ground, on removal from the pans, large numbers of the seedlings die. It should be noted that, while the methods described furnish an excellent means of obtaining numerous seedlings whose parentage on both sides is known with approximate certainty, yet none of them is sufficiently exact for conducting hybridization work on strictly accurate Mendelian lines, since none of them entirely precludes the possibility of the occasional formation of self-fertilized seeds on the female arrow through the agency of the fertile pollen grains, which may occasionally be produced in the anthers of varieties whose pollen is usually sterile.

DIFFICULTLY REFINED RAW SUGARS. *By J. Weisberg. Sucr. Belge, 1911, 40, 35-39.*

Although the great strides made in the agriculture and technology of sugar has had as a result an increase in the rendement and a diminution of the cost of manufacture, it would appear from the recent numerous complaints made by refiners that the quality of the raw sugar produced has suffered. It is in Germany that the highest rendements are realized, and it is just in that country that charges against the quality of sugars for refining are most frequently to be heard. At a recent meeting of the *Verein* held at the *Institut für Zuckerindustrie*, in Berlin, Prof. Dr. von Lippmann spoke on the causes of the different refining values of raw sugars having the same commercial titre. He drew the attention of his audience to the gradual increase of the ratio between the ash and the organic matter in the case of the raw sugars worked by the Halle refinery, this ratio being at the present time

1 : 2·2, and at times even 1 : 3·3, against 1 : 1·1, obtaining for the period 1873-1892. The quality of raw sugars having strongly decreased during the last 20 years, it is not astounding that yields in the refinery should not have improved during the same time. Each beet factory endeavours in every possible way to lower the ash content in its raw sugars, in order to increase the theoretical rendement, as calculated by the coefficient 5; but none take any account of the real quality of the sugars produced, and of the increasing content in organic matter. It is stated that the raw sugars worked by German factories are formed for the greater part of insufficiently developed crystals, which are not really transparent, but are cloudy, and often coloured through and through. There seems to be no doubt that this bad quality of raw sugar is harming the reputation of the German sugar industry in the markets of the world, that country being obliged to export a large proportion of its production of both raw and refined. In Austria, where the conditions appear to be somewhat better, there are, however, also complaints as to inferior raw sugars. Prof. Strohmer, writing on the presence and determination of raffinose (this *Jl.*, 1911, 402), has likewise remarked that the quality of raw sugars has been markedly lowered within recent years, and that the sucrose by double polarization differs very appreciably from the sucrose by direct polarization in the case of low grade sugars resulting from largely returning the after-products. Then in Russia, A. Tolpyguine says in regard to white "sand" sugars, that some factories in his country "obtaining bad quality sugars seek to mask their unfavourable appearance by blueing with ultramarine," and adds that in his opinion the inferior quality of some Russian sugars now on the market is to be attributed to the abuse that is made of sulphurous acid. As to the causes in the case of German factories, Prof. von Lippmann enumerates the following :—Too little lime is often used; defecation does not last long enough; carbonatation is sometimes effected at too low a temperature; the design of the evaporating plant may not be adequate; the temperature usually employed in the effects is too high; and, lastly, chemical control very frequently leaves much to be desired.

LOSSES IN THE MANUFACTURE OF SUGAR FROM THE CANE. *By L. Giraud. Bulletin (Mauritius), 1910, 1, 13-14.*

In this article some interesting figures relating to the sugar losses in a cane sugar factory in which all the massecuites are weighed and analysed by the double polarization (Clerget) method are given. Throughout the results are expressed as percentages on the cane worked: sugar in the cane, 13·51; sugar in the juice, 12·22; sugar in the first jet massecuite, 11·65; first jet sugar extracted (8·68 at 98·5 per cent.), 8·55; sugar that should be present in the second jet

massecuite, 3·10; sugar found in the second jet massecuite (3·94 at 62·14 per cent.), 2·45; loss (part of which passes into the third jet tanks), 0·65; second jet sugar extracted (1·344 at 96 per cent.), 1·29; sugar that should be present in the third jet massecuite, 1·16; sugar found in the third jet massecuite (3·03 at 45·95 per cent.), 1·39; loss of sugar, first to third jets, 0·42; third jet sugar extracted (0·706 at 87 per cent.), 0·61; sugar that should be present in the molasses, 0·78; sugar actually found in the molasses (2·32 at 34·8 per cent.), 0·80. Summarizing these losses, we have:

	Per cent.
Lost in the bagasse	1·29
Lost in the scums (1·80 at 8·76 per cent.)	0·16
Lost as far as the triple effect and pans	0·41
Lost in the boiling of first, second, and third sugars	0·42
Lost in the molasses	0·80
Total actual loss	3·08

Sachs (Bulletin, France, 1905-1906, 1000) has given the comparative results for Belgian and Dutch beet factories for 13 campaigns (period not stated), and it is seen that the average loss from juice to first jet massecuite, expressed on the weight of roots, is:

	Average		Per cent.
Belgian factories, average,	0·54;	of which the unknown loss is	0·43
Dutch ,, ,,	0·37	,, ,, ,,	0·24

While for the period 1902-1905 the figures are:

	Average		
Belgian factories, average,	0·47;	of which the unknown loss is	0·36
Dutch ,, ,,	0·34	,, ,, ,,	0·19

In the values given by the author for a Mauritius factory the unknown loss up to boiling in the pans is 0·41 per cent. on the cane, which includes the loss in defecation, by inversion, by entrainment, and by caramelization in the quadruple. It is pointed out that if the juice entering the factory be not examined by Clerget this loss may be seemingly diminished by 0·10 to 0·20 per cent. on the cane.

Diffusion of Bagasse. *By H. Pellet. Bulletin (Mauritius), 1910, 1, 17-22.*

At the Congress of the *Association des Chimistes de Sucrerie de France and des Colonies*, held in 1910, Naudet presented a memoir, entitled "The Diffusion of Bagasse" (Bulletin, France, 1910), upon which the present author now offers a few observations. Naudet holds that strictly speaking the term "diffusion" is improper, since cane does not contain cells, "but on the contrary infinite quantities of capillary tubes passing from one node to the other" (*loc. cit.*). It is now pointed out that, according to some authorities, cane does contain cells, as the following lines from Payen's book clearly show:—"Crystals of sugar more or less voluminous can be discerned in all the thin-walled cylindroid *cells* that surround the numerous bundles of woody fibre and vessels from the axis to the furthest

concha of vascular and woody bundles." Another extract from the same treatise is ". . . first sacchariferous *cells*, the smallest bordering on the vascular and woody bundles. In the small sacchariferous *cells*, granules of starch can be noticed, such as is observed in the tissues of very young cane." And again, ". . . *cells* gradually becoming larger as they are distant from the vascular bundles that they surround." It is held by the present author that there are certainly infinite quantities of capillary tubes, which, however, are not continuous, but are separated from place to place by an excessively fine membrane, and it is just these partitions that prevent the penetration of water. These cells are far from all being opened after the several crushings that cane undergoes, but then assume a rather elongated shape. The next point dealt with refers to the crushing of the bagasse and the thickness of the layer to obtain the best result. It was noticed by the author a number of years ago that if a certain quantity of bagasse be soaked in water, and this submitted to pressure in a small hydraulic laboratory apparatus, then the greater the amount of material used proportionately more juice will be obtained. For example, the results to be found would be as follows:—250 grms. of bagasse, 25 per cent. of juice; 500 grms. of bagasse, 28-30 per cent. of juice; and 1000 grms. of bagasse, 25 per cent. of juice. Lastly, the question of the re-pressure of the diffusion bagasse, and whether it is necessary to reduce the water content from about 50 to 42 per cent., is commented upon, and it is shown that the average figures for the water content of bagasse for a number of years are: (*a*) in Java 45-49 per cent., and (*b*) in Hawaii 44-48 per cent.

LOSS OF SULPHUR IN CANE SUGAR MANUFACTURE. *By L. Giraud.* *Bulletin (Mauritius)*, 1911, *2*, 15.

On comparing the quantities of sulphur burnt at the *Alma* and *Mon Désert* estates in Mauritius during the whole of the last campaign, and determining the acidity by the alkalimetric method, the author has obtained the following useful results :—

	Alma.		*Mon. Désert.*	
Sulphur burnt	22,000	..	21,000	kilos.
Corresponding to sulphuric acid (SO_3)	55,000,000	..	52,500,000	grms.
Volume of the acid juice..	48,352,362	..	48,741,667	litres.
Acidity (in SO_3), calculated	1·14	..	1·077	grms. per litre.
Acidity (in SO_3), found ..	0·90	..	0·878	,, ,,
Acidity of the first mill juice	0·17	..	0·20	,, ,,
Acidity due to sulphurous acid	0·73	..	0·678	,, ,,
Calculated to sulphur ..	14,118	..	13,218	kilos.
Sulphur lost	7,882	..	7,782	,,
Loss on the sulphur burnt	35·8	..	37·0	per cent.

It is pointed out that these losses coincide with the values stated by de Sornay in a recent article (this *Jl.*, 1911, 281), who determines

the sulphurous acid by titration with standard iodine solution. This shows that the alkalimetric determination is sufficiently exact for routine work, and the author prefers to use this method, employing the Pellet delicate litmus paper as indicator.

OCCURRENCE OF GUM LEVAN IN SUGARS. *By W. G. Taggart. Jl. Ind. Eng. Chem., 1911, 3, 646-647.*

Levan was first obtained on inoculating sugar solutions with *B. levaniformans* by Grieg Smith and T. Steele, who have made a very complete study of this gum. In connection with the interesting work on "The Bacterial Deterioration of Sugars" (this *Jl.*, 1911, 257, 316 and 378), by W. L. Owen, it became necessary to again study levan. On comparing the monthly analyses of a large number of raw sugars, it was found that the difference between the direct polarization and the sugar by Clerget could not be accounted for by inversion due to deterioration, and in some cases, while the direct polarization was found to decrease, the sucrose by Clerget slightly increased. Bacteriological examination showed that all the sugars contained large numbers of the gum-forming organism, and it was further found that if gum levan be present in a sugar the direct polarization is decreased 0·6°V. for each percentage of gum; while at the same time the sucrose by Clerget is increased by 0·67°V., since the levan hydrolyses to levulose on treatment with acids. In order to prove that levan was responsible for the unusual changes found to take place in these sugars, attempts were made to separate the gums from solution by precipitation with alcohol rendered slightly alkaline by sodium hydroxide. This method, however, threw down so much of the other gummy matter at the same time that it was found impossible to separate small quantities of the levan, even when it has been added. By adopting special methods, it was nevertheless found feasible to effect the separation of levan from inoculated sugars, and this was done in the following way: two solutions, each 5 litres, containing 14 per cent. of Peruvian crystals were thoroughly sterilized, then inoculated with yeast, and allowed to ferment. When most of the sugar had disappeared, the solutions were filtered, and both concentrated to a litre. To this was added 3 litres of alcohol, made alkaline with sodium hydroxide, to throw down the gum. After re-dissolving and re-precipitating this gum four times, a small quantity was obtained which was polarized, hydrolysed, and the resulting levulose examined, the following results being obtained:—

	No. I.	No. II.	Control using pure Sugar.
Polarization of gum	—0·35 ..	—0·24 ..	00·0
Polarization of hydrolysed product	—0·72 ..	—0·51 ..	00 0
Theoretical polarization	—0·78 ..	—0·53 ..	00·0

Attempts were also made to find a means of avoiding the error in analysis which is caused by the presence of levan (*Cf.* this *Jl.*, 1911, 322 and 333). Hudson's invertase method (this *Jl.*, 1910, 192) and

the Andrlik method of taking the direct polarization in an acid medium (this *Jl.*, 1911, 149) were tried, and found unsatisfactory. In making the direct polarimetric reading in a solution containing acid and urea, the author found that the rate at which the sucrose was inverted was faster than that at which the gum was hydrolysed.

DETERMINATION OF REDUCING SUGARS IN CANE MOLASSES. *By Ch. Müller. Bulletin (France), 1911, 29, 71-72.*

Instead of incinerating the reduced cuprous oxide obtained in determining the reducing sugars in molasses, in the way first recommended by Pellet, the author prefers to titrate with potassium cyanide, and proceeds as follows :—A solution of the molasses in water is first prepared, and this must be of such a concentration that the volume taken for the determination will give 0·022 grm. of calcined cupric oxide. In the case of a molasses containing 15 per cent. of reducing sugars, the amount of molasses to be used is 0·666 grm., so that a convenient solution to prepare is one containing 13·32 grms. of the sample in 200 c.c., 10 c.c. of which are taken for the determination. Hence, into two beakers are introduced 10 c.c. of the molasses solution, 50 c.c. of Fehling's solution, and 40 c.c. of distilled water; while into a third beaker is placed 20 c.c. of a solution of invert sugar, containing 5 grms. per litre, 50 c.c. of Fehling's solution, and 30 c.c. of water. These three beakers are placed in a boiling-water bath, and kept there for five minutes after their contents has reached 86-88° C., as ascertained by a thermometer placed in one of them, care being taken to agitate the solutions from time to time. At the end of the five minutes, 100 c.c. of cold, distilled water are added to each beaker, and the liquids then filtered through filter-paper, preferably Berzelius No. 0, and washed with boiling distilled water till the filtrates are no longer alkaline. If Pellet's procedure is used, the three filters are now calcined in weighed platinum dishes, which are again tared after cooling. According, however, to the author, when for some reason or other there is partial reduction of the calcined oxide, it is best to determine the copper by the following volumetric process: The three filters containing the cuprous oxide, instead of being placed in platinum dishes and calcined, are introduced into three small beakers, 5-6 c.c. of conc. hydrochloric acid added, and then 10 c.c. of ammonium hydroxide (sp. gr., 0·920). After cooling, these three liquids are titrated with a solution containing 46 grms. of potassium cyanide per litre (1 c.c. of which = 0·01136 grm. of copper; and 0·006 grm. of reducing sugars), which is run in from a burette until the blue colour just disappears, being converted into a faint, lilac tint. Having ascertained the amount of copper obtained from a definite amount of the invert sugar solution under these conditions of working, it is easy to calculate by rule of three the amount of invert sugar, or rather reducing sugars, in the molasses solutions, and consequently in the sample under examination.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. THOMPSON, C.E., F.C.S., M.I.M.E. Chartered Patent Agent, 6, Lord Street, Liverpool; 77, Market Street, Bradford; and 285, High Holborn, London.

ENGLISH.—APPLICATIONS.

19858. F. T. M. EVERARD and F. SEVERUS. *Manufacture of sugar.* (Complete specification.) 6th September, 1911.

16498/10. W. BOYD, Dundee, Scotland. *Improvements in and relating to apparatus for boiling and cooling sugar and the like.* Date of application, 11th July, 1910. This invention has for its object an apparatus for boiling and cooling sugar and the like, the use of a cooler consisting of a cylindrical drum internally cooled by circulating water with a scraper for removing the cooled sugar from the surface of the drum and the means for supplying a thin film of water to such surface.

GERMAN.—ABRIDGMENTS.

236842. STEFAN VON GRABSKI, of Kruschwitz, Posen. *A centrifugal having a conveyor worm arranged co-axially in the drum.* (Patent of Addition to Patent No. 220701 of 10th July, 1908.) 26th February, 1910. This is an improvement of the arrangement of the conveyor worm in the drum set forth in the original Patent No. 220701, the driving means which are mounted loosely on both shafts or only on one shaft and the driven parts being connected with the respective shafts by means of well-known self-releasing clutches.

237393. GENTRUP and PETRI, of Halle-on-Saale. *A shutter for beetroot washing troughs.* September 22nd, 1910. This shutter consists of a number of tines forming a grating and lying at an inclination to the direction of the current, which tines are mounted so as to oscillate by means of a lever, so that when dropped into the washing trough they are drawn down by the impetus of the travelling roots and so close the trough or channel with certainty.

NOTE.—Copies of all published specifications with their drawings in these lists can be obtained from W. P. Thompson & Co., 6, Lord Street, Liverpool, at One Shilling each copy for English or American Patents, and Two Shillings for German. In ordering please give number and date.

UNITED KINGDOM.

IMPORTS AND EXPORTS OF SUGAR
To End of Sepember, 1910 and 1911.

IMPORTS.

Unrefined Sugars.	1910. Tons.*	1911. Tons.*	1910. £	1911. £
Russia	93	1,404	1,190	15,945
Germany	98,964	391,584	1,330,533	4,261,934
Netherlands	9,281	6,748	115,618	77,320
Belgium	3,247	14,301	40,073	167,309
France	431	244	6,260	2,366
Austria-Hungary	41,171	40,808	548,618	414,027
Java	106,666	67,013	1,466,663	962,659
Philippine Islands	....	2,500	....	21,779
Cuba	96,335	3,861	1,371,613	29,610
Dutch Guiana	5,447	4,835	79,300	60,658
Hayti and San Domingo	76,504	28,141	1,078,015	307,605
Mexico	10,639	7,526	150,953	91,656
Peru	40,452	20,044	534,803	194,233
Brazil	50,428	13,346	609,794	121,752
Mauritius	39,025	45,877	565,969	481,690
British India	8,871	1,744	96,674	14,399
Straits Settlements	792	364	9,389	3,544
Br. West Indian Islands, Br. Guiana & Br. Honduras	70,106	50,571	1,029,913	683,639
Other Countries	23,090	13,227	308,670	134,166
Total Raw Sugars	681,541	714,138	9,344,048	8,046,291
Refined Sugars.				
Russia	94	71,435	1,452	995,371
Germany	243,634	315,253	3,875,945	4,337,898
Holland	63,197	96,281	1,059,664	1,415,649
Belgium	22,164	36,005	386,607	553,627
France	58,459	4,763	970,619	71,806
Austria-Hungary	142,724	160,394	2,357,097	2,240,952
Other Countries	77,714	12,727	1,320,275	190,684
Total Refined Sugars	607,987	396,860	9,971,659	9,805,987
Molasses	115,362	105,646	523,835	431,572
Total Imports	1,404,890	1,516,644	19,839,542	18,283,850

EXPORTS.

British Refined Sugars.	Tons.	Tons.	£	£
Denmark	2,936	3,485	42,962	42,490
Netherlands	2,405	2,171	36,929	30,019
Portugal, Azores, & Madeira	1,088	715	16,261	8,289
Italy	158	979	2,226	11,548
Canada	6,962	6,679	113,400	98,260
Other Countries	6,893	8,327	127,652	133,226
	20,442	22,356	339,430	323,832
Foreign & Colonial Sugars				
Refined and Candy	536	960	10,372	14,496
Unrefined	3,869	5,884	55,282	71,406
Various Mixed in Bond	75	....	1,285	....
Molasses	281	322	1,983	2,180
Total Exports	25,203	29,522	408,352	411,914

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1911. Tons.		1910. Tons.
Total Receipts Jan. 1st to Sept. 28th..	1,778,850	..	1,897,927
Receipts of Refined ,, ,, ...	231	..	149
Deliveries ,, ,, ...	1,778,850	..	1,844,461
Importers' Stocks, September 27th....	None	..	56,816
Total Stocks, October 4th	87,000	..	176,310
Stocks in Cuba, ,, ...	4,000	..	26,000
	1910.		1909.
Total Consumption for twelve months ..	3,350,355	..	3,257,660

CUBA.

Statement of Exports and Stocks of Sugar for 1909, 1910 and 1911.

(Tons of 2,240 lbs.)	1909. Tons.		1910. Tons.		1911. Tons.
Exports	1,353,407	..	1,624,794	..	1,381,713
Stocks	73,223	..	112,618	..	28,070
	1,426,630	..	1,737,412	..	1,409,783
Local Consumption (8 months)..	41,820	..	41,710	..	42,880
	1,468,450	..	1,779,122	..	1,452,663
Stock on 1st January (old crop)..	....	..	....	..	....
Receipts at Ports up to Aug. 31st	1,468,450		1,779,122		1,452,663

Havana, 31st August, 1911. J. Guma.—F. Mejer.

UNITED KINGDOM.

Statement of Imports, Exports, and Consumption of Sugar for Nine Months ending September 30th, 1909, 1910, 1911.

	Imports. 1909. Tons.		Imports. 1910. Tons.		Imports. 1911. Tons.	Exports (Foreign). 1909. Tons.		Exports (Foreign). 1910. Tons.		Exports (Foreign). 1911. Tons.
Refined	703,500	..	607,987	..	696,860	601	..	536	..	960
Raw	582,405	..	681,541	..	714,138	2,717	..	3,941	..	5,884
Molasses	124,131	..	115,362	..	105,646	214	.	281	..	322
	1,410,036		1,404,890		1,516,644	3,532		4,761	.	7,166

	Home Consumption. 1909. Tons.		Home Consumption. 1910. Tons.		Home Consumption. 1911. Tons.
Refined	697,452	..	593,157	..	690,179
Refined (in Bond) in the United Kingdom........	443,142	..	468,918	.	497,709
Raw	88,844	..	115,939	..	101,492
Molasses	105,974	..	108,612	..	96,655
Molasses, manufactured (in Bond) in U.K........	52,148	..	49,999	..	59,401
Total..........................	1,387,560	..	1,336,655	.	1,445,436
Less Exports of British Refined.................	24,970	..	20,442	..	22,356
	1,362,590		1,316,213		1,423,080

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, SEPTEMBER 1ST TO 30TH, COMPARED WITH PREVIOUS YEARS.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1911.
161,300	179,650	123,930	119,100	56,130	640,110

	1910.	1909.	1908.	1907.
Totals	663,770..	700,060..	707,830..	894,640.

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING AUGUST 31ST, IN THOUSANDS OF TONS.

(Licht's Circular.)

Great Britain.	Germany.	France.	Austria-Hungary	Holland, Belgium, &c.	Total 1910-11.	Total 1909-10.	Total 1908-09.
2001	1397	777	675	249	5098	4682	4709

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1910-1911.	1909-1910.	1908-1909.	1907-1908.
	Tons.	Tons.	Tons.	Tons.
Germany	2,600,000 ..	2,033,834 ..	2,082,848 ..	2,129,597
Austria	1,538,000 ..	1,256,751 ..	1,398,588 ..	1,424,657
France	720,000 ..	806,405 ..	807,059 ..	727,712
Russia	2,140,000 ..	1,126,853 ..	1,257,387 ..	1,410,000
Belgium	285,000 ..	249,612 ..	258,339 ..	232,352
Holland	222,000 ..	198,456 ..	214,344 ..	175,184
Other Countries .	590,000 ..	465,000 ..	525,300 ..	462,772
	8,095,000	6,136,911	6,543,865	6,562,274

THE

INTERNATIONAL SUGAR JOURNAL.

No. 155. NOVEMBER, 1911. Vol. XIII.

☞ All communications to be addressed to the Editor, Office of "The Sugar Cane," Altrincham, near Manchester. All Advertisements to be sent direct.

☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

Cheques and Postal Orders to be made payable to NORMAN RODGER, Altrincham.

The Editor will be glad to consider any MSS. sent to him for insertion in this Journal and will endeavour to return the same if unsuitable; but he cannot undertake to be responsible for them unless a stamped addressed envelope is enclosed.

NOTES AND COMMENTS.

The Month.

The principal event of the last month has been the special meeting of the Brussels Commission to consider the application of Russia to be allowed to increase her expert contingent for this season by 400,000 tons. This application has been received favourably, but the Commission seized the opportunity to try and get Russia to continue the Convention on the old basis in return for this concession on their part, and she is accordingly given till December 8th to make up her mind whether she will accept the condition or not. Russia was stated to have over 500,000 tons available for export. But there are rumours that all has not gone well with the Russian harvest, that an unfavourable change in the weather has affected the field operations at the eleventh hour, and that in the Kieff district quite one-third of the beets may be destroyed. If this were the case, it would greatly modify the situation, as Russia would obviously have a smaller contingent to export in the end; but as there is little or no confirmation of these statements by Continental sugar experts, we must accept them with all reserve.

The sugar market for 88 per cent. beet has been mostly nominal; at the beginning of October it was about 17s.; it advanced to 18s. 3½d. on the 9th on receipt of further discouraging news of German crop yields, and the month closed with prices at about 16s. 9d. Licht's

estimate, as will be seen on another page, gives a beet crop of 5,975,000 tons as against 8,095,000 tons last season. He estimates the Russian crop at 1,800,000 tons, while others place it as high as 1,961,000 tons. Probably Licht's will prove the most accurate forecast, having regard to the rumours already referred to of an incomplete harvest. As to the cane crop, there has been nothing noteworthy to chronicle, save that the Formosan crop is stated to have suffered serious damage from recent storms and, it is alleged, will be reduced by between 15 and 30 per cent. This, if true, would defer any Japanese designs on the Occidental market for another year, and might even result in Java sugar being again drawn on to supply the Japanese refineries.

The interest in a home beet sugar industry continues unabated if less demonstrative in character, and the publication within the last few weeks of a book dealing with the pros and cons of the problem from the pen of one of our leading agricultural journalists will enhance interest still more, and should gain further converts. We have heard less of propaganda work in agricultural centres of late; but undoubtedly some headway is being made in the process of inducing the farming community to try their hands at the new culture. Cornwall has been the most prominent of the counties of late; the Beet Sugar Pioneer Association of Liverpool have been carrying on a vigorous campaign in the Hayle district, and have offered prizes to the local farmers for the best beets grown this season. As is usually the case in experimental crops of this kind, the results have been far above the German *average;* but, allowing more fully for that than the propagandist'experts do, it seems certain that Cornwall is particularly suited for beet cultivation, and there are good prospects of a sufficient acreage being guaranteed to warrant the erection of a central factory. There is also a possibility of a factory being started in Burton-on-Trent under the auspices of the same Liverpool association; promises of financial support are said to be coming in well. Finally, there is the Norfolk scheme which is being watched by the Board of Agriculture with every interest short of active interference or support. The roots are now being despatched to the factories in Holland, and the farmers profiting by the mistakes of last year have produced a much more promising shipment, the tabulated results of which will be placed on record in the course of the next few weeks. If, as there is some reason to anticipate, the profit made by the farmers proves a satisfactory one, it will stimulate the promotion of a Norfolk factory at an early date.

Sugar Cane in India.

Dr. J. Walter Leather contributes an interesting paper to a recent number of the *Agricultural Journal of India* in which he investigates the causes that lead to India—herself a sugar producing country—

importing more than half a million tons of sugar annually. He points out that whereas 20 years ago this huge country purchased 100,000 tons of foreign sugar, the quantity has now risen to 600,000 tons. And yet India produces more sugar than any other country, the estimated amount being about three million tons. If India is to avoid these imports she must grow more sugar; but this she will only do if (i.) the price of sugar rises, or (ii.) the crop can be raised more cheaply, or (iii.) more sugar can be produced per acre. As to (i.) it may be said at once that the price for many reasons is not likely to rise; in respect of (ii.) it may also be said that there is no probability of labour getting cheaper, as wages are more likely to rise than fall. The present cost of cultivation is estimated by Hadi at 65-80 rupees per acre, which compares with Rs. 26 in Louisiana and Rs. 30 in Java. The solution of the problem seems to depend most on condition (iii.); if India is to reduce her imports of sugar she must increase her outturn per acre and extract a larger proportion of sugar from the cane.

Dr. Leather first turns to the question of extracting more sugar, and after detailing the various types of mills to be found in India, ranging from the best steam driven mills down to bullock rolls, he proceeds to show that it is a fallacy to suppose that were the cane all double-crushed in the best power mills the actual increased yield would be equal to the theoretic one. The great distance from the mills at which cane is grown would militate against the regular supplies so necessary to the economical working of a big factory and would lead to considerable losses through the deterioration of the cut cane. Whatever extension of steam power crushing there may be in the near future—and it will not quickly supersede the older mills—Dr. Leather is certain that this will not make any large difference in the amount of sugar which is obtained from the cane actually grown.*

If the production is to increase, it must rather be by means of (*a*) a larger outturn of cane per acre, (*b*) the cultivation of cane yielding more sugar at the mill, and (*c*) an extension of the area under cane. India, it may be pointed out, yields from 2·5 tons (in Bombay) to 0·6 ton (in Punjab) sugar per acre, which compares badly with the three to four tons in Java, and about two tons in most British colonies. The Indian crop is clearly on the low side; its chief defects consist in the small weight of cane per acre and the high proportion of fibre in the cane which results in a low yield of juice; the proportion of sugar in the juice is not small, however. To remedy these defects is not a simple matter. The favourite cane of Hindoo planters is the *Ukh*, which contains a high proportion of fibre. The preference

* The reader may be referred here to an article in our June issue, on the subject of sugar in India in which Mr, Martineau outlines a scheme for enabling the native to contribute towards the supply of white sugar by means of a very small alteration in his plant; this scheme is calculated to avoid the losses occasioned by the distant transit from field to central factory.

shown it is in part due to its comparative immunity from the attacks of wild animals. It will be necessary to find a substitute that will combine the advantages of the *Ukh* with a much higher sugar content; but local environment affects canes greatly in India and will restrict the use of particular species to certain districts. Each district will require a separate Experiment Station to evolve a cane best suited to the local conditions. If then better canes are produced, the quantity of juice from the acre of cane will increase, especially if more care is bestowed on the problem of manuring, a feature which on the whole is not adequately attended to in Indian sugar agriculture.

Passing from the above considerations to that of the possible extension of the area under cane we are met by the awkward fact that despite the increase in the total general cultivated area of India, there has of late years been a contraction of the area under sugar cane. The explanation is the simple one that other crops remunerate the cultivator better; thus in Madras in spite of increased irrigation facilities—the people find it pays better to grow cholum (*Andropogon sorghum*), while in Eastern Bengal where the climate is peculiarly favourable to the requirements of the cane crop, *jute* holds the field.

A Difficult Problem.

It is evident then that the problem of extending and modernizing the Indian sugar industry is a most complicated one. Dr. Leather has confined himself to the agricultural difficulties; but there are also problems relating to the consumption, which latter after all regulates the supply. The sugar consumption in India, as Geerligs has shown in his most recent work on sugar, is hampered by caste restrictions which insist on certain modes of manufacture and eschew others for fear of religious defilement. That so large an amount of foreign sugar can be disposed of in India is due to the way the wholesale sugar users hoodwink the native population. Native sugar largely adulterated with foreign, and native sweets made with the same mixture, are unsuspectingly foisted on the public; but when it comes to trying to make the same class of sugar at their doors, the difficulties begin. It seems tolerably certain that India's promotion to the list of countries holding "visible supplies," in other words, her active share in the world's sugar market, is a vista that seems yet a long way off, and will not be realised for many a year.

Further Extensions in Formosa.

The Harvey Engineering Co., Ltd., of Glasgow, have lately received an order from the firm of Okura & Company, London, for another central factory for the Island of Formosa for the Niitaka Sugar Company. The engineer of this Company was sent to Europe to secure estimates for this new factory. He then returned to Japan

and placed the same before his principal, Mr. Takashima, of Okura & Company, Tokio. To settle the details satisfactorily, Mr. Takashima and his technical sugar adviser, Mr. Mamiya, then came to Europe and visited Glasgow, where the estimates to be considered were examined in every detail as to design of factory and the capacity of the various apparatus necessary for the most economical method of producing cane sugar. After due consideration, under the guidance of his technical adviser, Mr. Takashima decided to place the order with the above firm, whose design seemed best to suit his requirements. This order from the Niitaka Company, it may be added, is the sixth central factory that the Harvey Engineering Co. have received for Formosa alone, to say nothing of a small factory erected to the order of the Japanese Government in 1906, to be used as a technical school, wherein young Japanese were to be trained in the use of sugar machinery, and where also was taught the chemical science relating to the manufature of sugar. This factory was fitted up with various appliances for the production of different kinds of sugar, and has undoubtedly been found exceedingly useful to the Japanese industry, for from it engineers and factory managers have been provided for the large central factories now in operation in Formosa. In 1907 the Harvey Co. received the order for their first Central, that of Meiji. The same year saw the Ensuiko Factory also ordered. Then followed the Takasago Factory in 1909, the Yensuiko Factory No. 2, and the Takasago Factory No. 2 in 1910; and now the Niitaka Factory, 1911. The above list may be considered a good record, and shows the high standing and reputation which this firm now holds as constructors of central factories in the Island of Formosa.

This new central factory for the Niitaka Sugar Company is to be built on the firm's usual lines for the most economical method of producing sugar of any grade that may be required, and comprises a set of four mills with special crusher in front of the first, each mill consisting of three rollers, 34 in. diam. by 78 in. long. This is considered by many sugar experts the largest size of mill that can be used to advantage. A proof of this is that in Java, an island famed for the low cost of its sugar production, 60 per cent. of the mills in use there do not exceed 30 in. diam., by 60 in. long, the reason being that in the Java planters' experience mills of this size running at a high speed give the best results, and are much more easily handled. The juice from the cane will be treated in the usual manner and passed through a Harvey Patent quadruple effect.

It is interesting to note that out of two dozen central factories that have been erected in Formosa since 1907, about half have been ordered from Great Britain, all of which have been manufactured in Glasgow; of these the Harvey Engineering Co., Ltd., have accounted for six

(if we include their new contract) and the Mirrlees Watson Co., Ltd., have secured four others.

An outcome of the remarkable development of the Formosan sugar industry and of the sugar trade in Japan Proper is the decision of the Yokohama Seito Kabushiki Kaisha (the Yokohama Sugar Refinery Ld.) to amalgamate with the Meiji Seito Kabushiki Kaisha, one of the Centrals mentioned above, in order to further their business arrangements. The union is to commence from next January, the name of the latter of the two firms being retained to designate the amalgamated businesses. It is the intention of the firm to increase their scope of activity considerably; the manufacture of raw sugar being in contemplation as well as the existing refining industry.

The Extermination of the Cane Rat.

A recent issue of the *Australian Sugar Journal* devoted some space to a letter from one of its correspondents on the best means of coping with a plague of rats in the cane fields. This correspondent (a Mr. Jodrell), who is a planter on the Goondi estate in Queensland, found his cane farm so infested with rats that, in the course of two crops, it was hard to find a single cane stalk untouched by the rodents. He thereupon began experimenting to find the best means of extermination, and though his investigations proved long and tedious, they were finally successful, and the farm has since remained practically freed of the rat pest. Among the methods that proved unsatisfactory was that of mixing boiled rice with arsenic. This went mouldy very quickly, and, in any case, the rats refused to touch it. The same failure followed the soaking of corn in a solution of strychnine, and of oatmeal and molasses with arsenic—the rats would not touch the bait. Next, meat and bananas dosed with arsenic were tried, but seemed to have no fatal results. This supposition was confirmed by the trapping of two rats alive and feeding them on arsenic baits. They sickened a good deal at first, but, once recovered, the arsenic made no further impression on them. Mr. Jodrell eventually found that the most effective poison was strychnine steeped in such food as the rats were ordinarily accustomed to feed on. But the time to lay down the bait is when the crop has been reaped and removed, or ~~else~~ when the cane is still unripe. Either bananas, canes, or sweet potatoes can be used; these should be cut sufficiently open to have their interiors sprinkled with strychnine powder, and then be closed up again, whereupon the bait is ready for distribution among the haunts of the rats. One very necessary precaution is to scent the hands of the operator with aniseed essence; this does away with the human smell on the bait, and is, moreover, an additional source of attraction to the rats. As to the cost of the process, this is but trifling; a five shilling bottle of strychnine and a shilling bottle of aniseed

should last a whole season even on a badly-infested farm. It is only necessary to add that the measure of success achieved depends to a large extent on concerted action. It is no use one planter poisoning rats while his neighbours contrive to breed him a fresh supply.

Dumping Australian Sugar into South Africa.

Complaints have lately been heard that Australian sugar is being dumped into South Africa at prices which are not regulated by the values ruling at any given time in other parts of the world. A representative of the Natal sugar industry who drew the attention of the authorities to this fact adduced some evidence in support of his contention. He showed that whereas on January 9 last when 88 per cent beet was quoted at 8s. 10½d. f.o.b. Hamburg, he was able to buy Australian sugar at 13s. 5d. per 100 lbs. c.i.f. Durban, yet he later on bought Australian sugar at 13s. 3d. when 88 per cent beet was 12s. 6½d. Thus while the world's price had gone up 3s. 8d. per cwt. the Australian price had actually dropped by 2d. As Australia is on the lookout for fresh markets for her surplus sugar, it may be assumed that she will not readily abandon her opportunity of dumping more or less large quantities into South Africa, all the more as the latter imposes the lowest duties of any country that Australia can export to. It will therefore rest with the South African Government to decide whether Natal's sugar industry shall be protected from the competition of sugar which the Brussels Permanent Committee have declared to be bounty-fed; and if so, whether by the simple method of imposing a countervailing duty to the extent of the bounty.

The Chaparra Central, Cuba, finished for the season on August 12th, having ground 455,112 sacks of sugar (66,032 long tons) as compared with 531,049 sacks in 1910. The owners, the Cuban-American Sugar Company, have two new mills in course of erection that are expected to be ready for the new crop. These are to be known as Delicias and San Manuel. The output of the above three centrals is expected to run to 1½ million sacks (217,634 long tons).

According to a Manila paper, a rich Chinese business man at Amoy is erecting two sugar mills of modern design, which he has procured through Japanese agents from an American manufacturer. He has acquired large areas of hinterland and proposes to introduce modern methods of cane cultivation. Cane cuttings are being imported from Formosa and Java to plant out in the new fields; and, in short, every effort is to be made by this enterprising Chinaman to emulate Formosa.

THE BRUSSELS CONVENTION.

Special Meeting of the Permanent Commission.

The Permanent International Sugar Commission has been summoned to meet in Brussels on October 26th, to consider a communication from the Russian Government inviting the States parties to the International Sugar Convention to accord to Russia an increase in the quantity of sugar which she has been permitted, by the terms of the Protocol of 1907, to export annually. The increase is asked for only for the present campaign and the amount is not stated.

The situation is quite unique and unparalleled. There is to be a deficit in the European production of beetroot sugar of something like 1,500,000 tons or more, owing to the dry summer; but Russia has had good weather and expects to produce 1,800,000 tons. The Russian stock of disposable sugar is already excessive and will be overwhelming when the new crop has been secured. The world is being starved for sugar owing to the enormous reduction in the beetroot crop in Europe, and Russia, by the terms of the Protocol of 1907, is prevented from coming to the rescue. She is absolutely compelled to hold enormous stocks of unsold sugar when they might be easily disposed of at most remunerative prices. The busy opponents of the Sugar Convention have invented many stories in order, if possible, to bring it into disrepute, but their bubbles have always burst. Now they have a real live shell to throw into the enemy's camp. Sham Free Trade has at last given them their opportunity.

Under these circumstances the progress of events ought to be unusually interesting. In the first place what will the other Powers say and do? The *Economiste Français* merely declares that such a situation cannot be tolerated and that it is necessary at once to repair this Convention. What are the repairs to be? M. Dureau, the editor of the *Journal des Fabricants de Sucre*, gives a very distinct reply. There can be only one answer, he declares, to the demands of Russia, namely, "either the pure and simple execution of the contract entered into, or the immediate reform of the Russian legislation in conformity with that of the Conventional countries." That, in our opinion also, is the only satisfactory solution of the difficulty. Great Britain backed out of the undertaking entered into by the British Government in 1902, an undertaking on the strength of which the Foreign Governments abolished their bounties, relying on the good faith of the British Government to maintain the security given to them in 1902, that they should never again be subject to bounty-fed competition on British markets. That security has been suddenly withdrawn, sham Free Trade has triumphed and the good faith of our country has been dragged in the mire. Freedom of competition ha been destroyed on our markets, and the only alternative left to ou

colleagues in this mutilated Convention was to patch up a bargain with Russia, the comical but fatal results of which we now see.

One thing seems certain, that the Permanent Commission can do nothing more than consider and suggest a remedy. Negotiations will then have to take the form of a special International Conference and the decision of the Conference, if it involves an alteration of the Protocol of 1907, will require ratification. In the meantime the bulls will be masters of the situation in the sugar market. All this confusion and delay will give the old opponents of the Brussels Convention a grand opportunity of again misleading and deceiving the British public, and it is, therefore, more than usually necessary to quell their onslaught by emphasizing the fact that under the terms of the Convention as originally drafted this trouble could never have arisen. It is because so called free traders preferred prohibition to a countervailing duty, and then, five years afterwards, re-established the so called free trade system of protection of the foreign producer in British markets, that we now find ourselves absolutely shut out from buying in the Russian market, where there is a glut of sugar, and are compelled to seek for supplies where they are scarce and dear.

In Austria it is urged that we must wait and see how scarce sugar will be presently, before we decide on the policy to be adopted. In Germany it is pointed out—very truly—that at present the contracting States, who have abolished their bounties on the express condition that they shall no longer have to face bounty-fed competition on British markets, already find themselves subject to such competition from Russia, where an enormous Cartel bounty, founded, organized and enforced by the Russian Government, has caused the sugar industry of that country to double its production very rapidly. They are now asked to permit this competition to be increased. Russia is carrying on an industrial and commercial war against the other European producers of beetroot sugar, and they are now asked to contribute to her war chest. In other words, they are asked to help in promoting the artificially stimulated increase in the Russian production. In point of fact prices are so high that Russia could afford to abolish its Cartel bounty, and then sell its surplus sugar on the world's market at a good price and free from all let and hindrance.

If this is the German view of the situation, it exactly arrives at the same conclusion as that quoted above from the *Journal des Fabricants de Sucre*.

The alternative suggestion comes from Belgium, namely, that Russia should be permitted to increase her exports temporarily for the season 1911-12. This would involve the maintenance of the Russian bounty for an indefinite period, which means a further and continuous abnormal increase in Russian production and Russian unsold stocks. There could not be a better opportunity than the one which now

presents itself for obtaining from Russia the abolition of her bounty. But with our mutilated Convention the task will not be easy.

There is a third alternative, namely, for Great Britain to break up the Convention in order that all the countries may make a fresh start at bounty-fed competition, and that we may once more fully enjoy the free trade régime of protection to foreign producers on British markets. Let Sir Edward Grey have the courage of his opinions and take this honest and straightforward course—and see what comes of it.

The factories' estimate of the crop has now been published, which indicates a shortage of about 2,000,000 tons in the whole of Europe, in spite of the fact that the Russian crop is estimated at 1,960,000 tons.

Since this was written the Permanent Commission has met, and Sir Edward Grey explained the situation as follows, in reply to a question in the House on the 2nd November:—

> The proposal submitted by Russia to the International Sugar Commission was that she should be permitted, during the period of the 1st September, 1911, to the 31st of August, 1912, to export 400,000 tons of sugar in excess of the amount of 200,000 tons allowed to her under the Protocol of the 19th December, 1907. The Commission decided to agree to the Russian proposal in principle, provided that a satisfactory arrangement was arrived at in regard to the conditions under which Russia would continue to be a party to the Convention; and the meeting was adjourned until December 8th next, to enable the Russian Government to submit further proposals on this point.

It appears from the latest Continental advices that the feeling in Belgium is in favour of authorizing an increased exportation from Russia for this campaign, but on the formal condition of a renewal of the Convention for a long period, without any increase in the normal contingent of Russian exportation. The *Deutsche Zuckerindustrie*, on the other hand, would prefer a different solution of the question, which in its opinion would be a greater concession to the Russians. It would demand that Russia should completely abolish its present system (the "Normirovka") tending to limit the quantity of sugar destined for consumption, and that it should then be at liberty to export as much sugar as it pleases. This would not injure the Russian industry because its great development in recent years indicates such strength that it no longer requires the large protection of the "Normirovka." The German journal adds that if the surtax permitted by the Convention is insufficient to protect the Russian frontiers it might be permitted to Russia to raise the import duty in proportion with the cost of transport from the south-west. The other Powers have no desire to compete against Russian sugar in Russia

itself, but they have a right to demand that on the world's market the competition should be on equal terms. The *Sucrerie Belge* doubts whether the other Powers would give to Russia free exportation of her sugar together with the maintenance of a high surtax. This, however, is not what the German journal proposes, but merely a duty to countervail unequal conditions of freight.

The *Sucrerie Belge* points out that as England has not remained a party to the Convention since 1908, except as a matter of form, her withdrawal from it would not in any way change the state of things (ne changera absolument rien à l'état des choses). It adds that England has no power to force the Continental Powers to re-introduce, against their wish, their old sugar bounties, merely to please the English.

GEORGE MARTINEAU.

SUGAR BEET AND ITS INDIRECT BENEFITS.

The late Sir Robert Giffen, commenting on a paper read before the Royal Statistical Society in 1899 (see the Journal of the Society for June, 1899), made the following remarks:—

> The next question he should like to put would be in what way the cost of producing beet sugar was to be ascertained? It might be quite true that the author could give very good estimates of the cost of producing cane sugar, because he understood that one crop of cane sugar after another was grown on the same soil. Beet sugar, however, was one of a course of production, and it was difficult to state the cost of producing a particular crop which was only one of two or three in rotation, though it would be possible to tell the cost of producing the three or four crops of which beet sugar was only one. He hoped the author would give some information upon the point, because it was of the essence of all the statistics with reference to the cost of production, and also with reference to the consideration of the future price of sugar. If it were the interest of the growers of beet sugar to go on producing it, quite irrespective of the special profit or loss which they made on it, for the sake of the other crops in the series, then it might not be so easy to affect the future production of beet sugar by means of countervailing duties or any other method.

These are not only weighty but also far-seeing words of that eminent statistician and economist, and are specially valuable at the present moment when the proposal of establishing the beet sugar industry in this country has become a burning question. Sir Robert Giffen did not know, with regard to the abolition of the European sugar bounties, that the proposal of a countervailing duty came originally from the

foreign Governments, who pointed out with undeniable force that they could not enter into an International Convention for the abolition of bounties unless Great Britain would give them security, in a penal clause, that they should never be exposed to the competition of bounty-fed sugar on British markets. This security was given in 1902, with Sir Robert Giffen's full approval, and the bounties were abolished. The production of beetroot sugar in Europe did not fall off; on the contrary, since that time the production has increased from 4,982,101 tons in 1898-9, when Sir Robert Giffen's words were uttered, to 6.933,649 tons in 1905-6, and 8,127,000 tons in 1910-11. It is only when there is a drought on the Continent that these figures have been reduced—for instance, to 4,708,758 tons in 1904-5, 6,185,000 tons in 1909-10, and to 6,000,000, the estimate for 1911-12, when the acreage planted should, under normal conditions, produce 8,000,000 tons.

These facts show that there was great force in Sir Robert Giffen's words, and that, in spite of the abolition of the bounties, the continental farmer has gone on growing sugar beet, and even increasing the acreage, because it paid him to do so. There is strong evidence to show that the inducement is, as Sir Robert Giffen foresaw, the benefit to his land and, therefore, to his other crops.

An excellent book has recently appeared on "Sugar Beet, some Facts and some Illusions, a Study in Rural Therapeutics," by J. W. Robertson-Scott ("Home Counties"), published by Horace Cox, at "The Field" office. The author deals with the whole subject, not only exhaustively but also in language and style which make even the driest parts interesting reading. What has been done and what is doing are first related, leading up to a full description of the agriculture and factory work of the industry. Then comes the knotty point of the cost of the crop, and this again leads up to the three main chapters of the work (chapters XVI., XVII., and XVIII.), "The Return in Cash," "The Return in Kind," and "The Further Return."

Let us look for a moment at this latter chapter—the further return—apropos of Sir Robert Giffen's remarks. Mr. Robertson-Scott gives the reader many quotations from good authorities, Continental, American, and British, stating and proving by figures and statistics that the sugar beet greatly improves the fertility of the soil, and that in all countries where the beet sugar industry has been introduced the crops of wheat and other cereals have been materially increased. The author is, however, careful to note that root crops may perhaps have been absent before the introduction of the sugar beet, and that this might, therefore, vitiate the comparison with the agricultural situation in Great Britain. But at the same time there is no doubt that the sugar beet stirs up and fertilizes the soil to a lower depth than mangel. The growth of the root is entirely below the surface, the tap root consequently reaching a much lower depth than that of the

mangel. The sugar beet also throws out quite a cloud of minute rootlets which reach to a considerable distance in every direction. These rootlets, as pointed out by Mr. Truman G. Palmer, Secretary of the American Beet Sugar Association, not only help to aërate the soil to a considerable depth, but as they are left in the soil when the root is pulled they help to form humus below the ordinary depth, and thus create fertility far below the depth of the plough furrow. Again, the sugar beet goes to the factory and yields up its sugar, a product entirely composed of elements drawn from water and the atmosphere, and the mineral matters—even the organic impurities, bad for sugar but good for land—are practically returned to the soil. The careful cultivation necessary for the successful production of good sugar beet makes the land absolutely clean; this and the necessary manures are of great value to the crops which follow.

A deputation of men well versed in agricultural matters was sent from Maidstone to study the question on the spot in the best sugar-beet growing districts of the Continent. Their report says (as quoted by Mr. Robertson-Scott):—

> The importance and value of beet growing is not to be gauged by the profit derived from the crop itself, but rather by its effect upon the whole rotation or, rather, upon the whole economy of the farm. It amounts to a premium on good farming. . . . .
>
> To our mind the great point to be remembered is that the year of *least* profit in any of our rotations is turned into the year of *greatest* profit on a beet farm. The farmer lends the produce to the factory, and receives it back rather reduced in feeding value, but with all the salts and minerals derived from the soil quite intact, and ready to be returned to the land from which they were extracted. It is not surprising that a few years of this treatment increases the letting value of the land. Agricultural land in the neighbourhood of Magdeburg has doubled in value since the introduction of beet growing.

This last statement is not of much account, because Magdeburg has grown—even to excess—the sugar beet for a very long time. It is, moreover, a statement which, if read by the British farmer, might at once determine him not to grow sugar beet. Such is human nature.

The Maidstone report gives an interesting calculation of cost of production, and then compares the money returns from a rotation, including sugar beet, with the money returns from the old rotation. The figures are interesting, and are given in Mr. Robertson-Scott's chapter XVI., pages 194-6. They require correction on one or two points, but the figures are perhaps more reliable than those usually put before the inquiring reader. It is too sanguine to "figure" on a yield of 15 tons to the acre. The expense of artificial manures is too low. Also some of the other crops might perhaps be credited with more profits.

But these figures do not illustrate Sir Robert Giffen's principle because they do not credit the beet rotation with improved yields of wheat and oats.

The *Journal of the Board of Agriculture* gives some figures illustrating "the way in which extensive areas in Germany and elsewhere have been improved by beet culture," which Mr. Robertson-Scott quotes. The following may be reproduced :—

> Lilienthal estimated, on the basis of eight farms, that the introduction of the cultivation of sugar beet had led to the following increases :—

Increase of live stock in the ratio	..	100 : 115
,, in corn production	,, .	100 : 111
,, in dung production	,, ..	100 : 132
,, in wages	,, ..	100 : 141
,, in net profit	,, ..	100 : 134

The British farmer would strongly object to the fourth line in this table. All the rest he would positively refuse to believe.

Mr. Robertson-Scott then quotes from "the most authoritative work on Dutch agriculture" the following :—

> It is not only on account of the area covered that beet culture is of great importance for agriculture, but on account of its special characteristics. Everywhere it is carried on the intensity of cultivation is heightened, the fertilization of the soil is increased, and the cattle feeding is improved.

A further chapter in Mr. Robertson-Scott's book deals again with this branch of the subject. It is headed "A Panegyric on Sugar Beet," by Truman G. Palmer, Secretary of the American Sugar Beet Association. It is a summary of an address delivered at the twentieth session of the Trans-Mississippi Commercial Congress, Denver, Colorado, August 7th, 1909.

This is worth reading, though intended for a popular audience, but Mr. Palmer has, since then, written a much more business-like essay on the subject, addressed to the United States Senate in July, 1911, entitled "Indirect Benefits of Sugar Beet Culture." (Senate, Document No. 76, 1911.) This document should be read by those who are interested in the question. At the conclusion of his paper, Mr. Palmer gives a "limited selection of letters and reports received from farmers located in beet districts, from Ohio on the east to Washington on the west."

The most useful statement in the body of the document is a comparison between the rate of increase in the crops in Germany where sugar beet is wide-spread and the rate of increase in the United States where sugar beet is only in its infancy. Mr. Palmer gives them as official figures :—

	Germany. 1878-1883. Bushels per acre.	Germany. 1909. Bushels per acre.	United States. 1879. Bushels per acre.	United States. 1909. Bushels per acre.	Increase. Germany. per cent.	Increase. United States per cent.
Rye	15·7	29·4	14·5	16·1	87·2	10·9
Wheat	19·2	30·5	13·8	15·8	58·8	14·2
Barley	24·5	39·4	24	24·3	60·8	1·2
Oats	31·8	59·1	28·7	30·3	85·8	6·7
Potatoes	115·5	208·9	98·9	106·8	80·8	7·6

We have now given enough quotations to indicate the importance of the question of the "indirect benefits of sugar beet culture." As to the general question of sugar beet there could be no better handbook to the subject than Mr. Robertson-Scott's exhaustive treatise. We can only regret that he did not omit details of crops sown too late, badly cleaned, carelessly treated, and grown on indifferent land in bad situations. We hope to hear a much better account of the crops grown in the Eastern Counties in 1911, and we have reason to believe that those improved crops—in spite of drought—will make their appearance. They will go to Holland to be turned into sugar, and it would be well that the Norfolk and Essex farmers should have an agent in Holland to see to the weighing and delivery.

At the end of his twenty-five chapters, which we do not profess to have reviewed properly on this occasion, Mr. Robertson-Scott adds an additional chapter, in which he gives a condensation of the report of the investigations made in Germany and France by Mr. R. N. Dowling, agricultural adviser to the National Sugar Beet Association, and formerly Lecturer in Agriculture, Hunts C. C. and Wye College, Kent. This chapter should attract attention; it is full of good sound information.

On a farm near Hildesheim, 500 hectares, of which 375 were arable (hectare = $2\frac{1}{2}$ acres), he found the estimated cost of production, inclusive of rent, rates, taxes, manures, &c., to be £12 10s. per acre, or £9 without rent, rates, and taxes. Return, 13 tons at 25s., £16 5s.; "therefore net profit, after deducting all costs, was £3 15s. per acre." At another farm near Göttingen the yield was 13 tons (these yields are all for washed and topped roots), and the farmer pointed out, what is too much forgotten, that the object is not to produce the largest weight of roots nor the highest percentage of sugar in the roots, but the largest yield of sugar to the acre. The average price of roots at the factory was 25s. per ton. "Farmer said his outlay is met by 20s. per ton." At another farm, "yield, 16 tons per acre. Factory pays on an average 24s." Mr. Dowling then sums up. "Thus we get:—

Yield, say 15 tons at 23s.	£17
Cost, including rent, rates, taxes, freightage, &c., say .	12
Net cash profit per acre	£5"

He would have been safer to have taken 13 tons and shown a profit of £3. Later on he says: "In Germany, *on good farms*, the average yield may safely be taken as 14 tons." In another place he says: "In fact I feel confident that the average English soils will more than equal the yield obtained on the German loams."

He gives us the figures from the great establishment at Kleinwanzleben, which are valuable. The estimated cost of cultivation per acre is given in full detail, and comes out to be: Labour, £4 19s. 3d.; manures, £3 0s. 9d.; total, without rent, rates, and taxes, £8. "Dr. Rabbethge maintains that, within reason, a fair sized root does not lower the sugar-content per acre." Yield "14 tons 10 cwt. per acre; winter, wheat, 50 bushels, of 63 lbs., to the acre; barley, 52 bushels, of 56 lbs., to the acre." Here we have evidence, in chapter and verse, of the indirect benefits of sugar beet culture.

For the benefit of Mr. Robertson-Scott's excellent book Mr. Dowling writes his conclusions. They should be well studied. On the subject of labour, he says: "In my opinion there should not be much difficulty in obtaining unskilled labour for work in this country. There are at present many hundreds of women and men at work in England among peas, strawberries, hops, and fruit." The work of hoeing is simplicity itself, and anyone could pick it up most easily. Speed comes with practice. The women look healthy and happy, and it would seem to offer a grand opportunity of emptying London and other places during the summer of the squalid poor." As to stock, he says: "The head of stock kept per acre is greater than in England. This is particularly interesting when we consider that in many parts of Germany and France no roots in addition to beets are grown." As to cost of production of roots he sums up by saying that in Germany the average cost is from £8 to £9 10s., exclusive of rent, rates, and taxes, and in France about the same. The rent of beet farms in Germany averages from £2 10s. to £4 an acre, whereas in England the rent runs from £1 to £1 15s. As the average yield, on good farms, "may safely be taken" as 14 tons, and the average cost of production is £9 (exclusive of rent), and the price paid not less than £1, and generally about £1 3s. per ton, "it will be seen that there is ample margin for profit," which is supplemented by the return of the slices at a moderate price" (or free), "the value of the leaves, which may be safely considered at £1 per acre, and last, but not least, by the increased fertility and cleanliness of the land."

Thus Mr. Dowling brings us back to the text of our discourse, the indirect benefits of sugar beet culture.

GEORGE MARTINEAU.

We learn that Mr. S. George Chiquelin has been appointed Director of the Audubon Park Experiment Station, New Orleans, U.S.A.

THE REQUIREMENTS OF THE BEET SUGAR FACTORY AS COMPARED WITH THE CANE SUGAR ESTABLISHMENT.

By Ed. Koppeschaar.

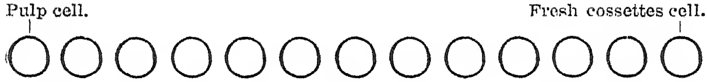
II.

The battery, as described in our last paper* and which, with the supervision of good technical and chemical control, will ensure good sugar extraction, has of late years been the subject of the inventive energy of experts and inventors.

Those apparatus that endeavour to bring the maximum temperature more forward, *i.e.* on fresher cossettes, start from the axiom that the osmosis will not take place if the plasma covering of the unopened cells has not been changed by the application of heat of about 70° C. They accomplish it in different ways, for instance, by re-forcing the specially heated raw juice back into the fresh cossette cells.

In the ordinary battery, these temperatures will very likely be as follows:—

Pulp cell. Fresh cossettes cell.



20°	40°	55°	55°	65°	65°	73°	73°	73°	73°	73°	55°	30° C.
68°	104°	131°	131°	149°	149°	160°	160°	160°	160°	160°	131°	86° F.

A gain forward will be beneficial, no doubt, but it will require specially complicated valves, handling and pumping.

The other modifications relate to continuous press-diffusion, being a combination of diffusion and pressing the cossettes, mixed with hot raw juice. Where the diffusion battery, as described, is already fairly complicated in handling and controlling, we would not, in the case where a good extraction is a desideratum, advise embarking on the newer processes, which have in view the manufacture as well of cattle food rich in sugar.

Whereas the bagasse in a raw cane sugar plant, leaving the last set of rollers with about 50 per cent. of water, may constitute the only fuel used, the exhausted cossettes or pulp, when freed from their excess of water, generally serve as a cattle food, thus bringing an additional fair remuneration to the factory owners.†

In this *Jl.* (*148,* 184) the various forms in which the pulp may be fed to cattle are briefly described as to their feeding value. Whether or not dried pulp is going to form part of the output of a new factory will, of course, depend on whether the farmers will readily buy the ordinary fresh pulp (and ensilage it) or not. In a country where pulp is unknown so far, there is more chance that the farmers will prefer

* See *I.S.J.*, October, pp. 527-536.

† In 1910-11 the pulp from Vierverlaten Sugar Factory brought in 2s. 9d. per metric ton beets in this way.

dried pulp, or, better still, *dried pulp saturated with hot molasses*, this forming an excellent food, equal to dried sugar cossettes. Where farmers do not object to fresh pressed pulp, a good plan would be to dry at least part of the pulp production, and some notes on the different drying systems and their *pros* and *cons* might be welcome here.

The necessary evaporation of the juice, and the expense of coal required, has put a limit on the extent of sugar extraction in practice; thus to leave less than 0·2 to 0·3 per cent. of sugar in the pulp would not justify the greater cost for coal. So when, guided by the constant control of the laboratory, the pulp is seen to contain about that sugar percentage, the undercover is opened and a concrete flume, slanting about 7·5 per cent., receives the pulp, which floats with the press-water towards a sink.

A pair of strongly-constructed pulp dredgers convey the pulp to a set of presses, while the water, separated by large sieves, is best pumped up and treated separately with the pulp press water, as already described (this *Jl.*, *149*, 246). The pulp dredgers are constructed at an angle, thus allowing the water to fall back into the pit. They are made of a series of perforated buckets fastened on strong chains, which run over drums or wheels.

The mammoth pump principle has been recently ingeniously applied to the lifting of the pulp. This new way, doing away with cover, flume, pit and dredger, deserves full attention, even if it lifts the water as well as the pulp. To relieve the pulp of part of this containing water, presses are used of two distinctly different types. A construction frequently met with consists of a vertical conical cylinder of cast-iron, with perforated plates screwed on. Iron palettes, arranged spirally, force the pulp downwards into a space formed by a surrounding sheet-iron casing, also perforated, which space gets gradually smaller. The other kind of press squeezes the pulp between two revolving discs, whose axes are inclined about 170°. The pulp, turned round with the discs, loses water, while the space narrows. These latter presses have a larger capacity, but require more force than the first-mentioned type.

When pressing out pulp, it should be remembered that the more we press the more the nutritive elements* are lost, especially nitrogenous compositions (the sugar itself is entirely lost in the ensilaging process).

If the pulp is to be dried by steam or by gases generated by special fires, the large amount of extra coal needed to evaporate the water demands that this quantity of water shall be limited, even if thereby some nutritive substances are lost. Thus pressing somewhat harder will be resorted to in order to reduce the coal bill. If the pulp be

* When we press to 16 per cent. dry substance, about 0·5 per cent. dry substance per beet weight is lost.

ensilaged, it is pressed to about 8 per cent. dry substance. Where, on account of the high temperatures (600° C. to 1000° C., or 1112° F. to 1832° F. for those installations using gases from special generators, and about 300° C. (572° F.) for the Huillard waste flue gas installation), these dryers successfully dry a material containing some 10 to 12 per cent. dry substance, the steam-drying installations require material pressed to about 16 per cent. dry substance and chopped fine, as otherwise, the already costly steam drying would lag behind too much as regards economy. The capacity of the two kinds of fire gas installations is evidently an elastic one; if the dry substance of the material received is somewhat higher, the amount of water to be evaporated is considerably smaller.

The limit of the drying process itself is set by the fact that dried pulp, containing 12 to 14 per cent. water, equal to 86 to 88 per cent. dry substance, will keep good if stored in a dry place, while drier material will readily absorb moisture till about the same percentage is reached.

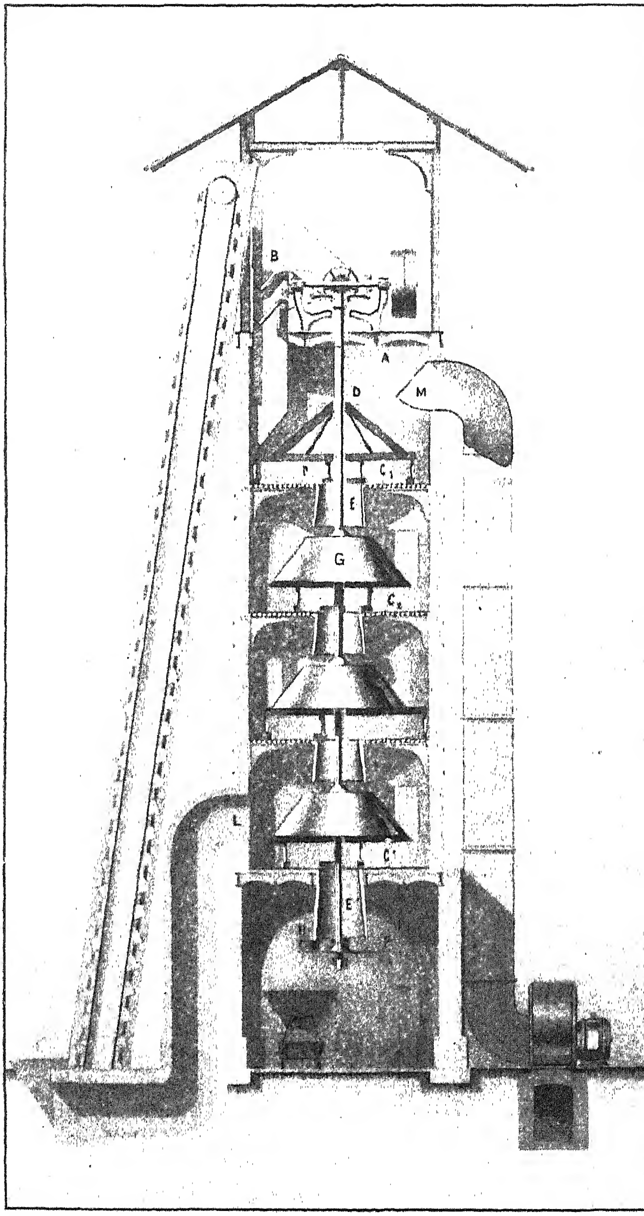
As to the quality of the dried article, all three kinds are being manufactured and readily sold. Those dried by hot gases, either from special generators or waste flue gases, will be apt to show a slight colour; but since special care is taken that the ashes are caught up in the large space behind the fire arches, and all smoke is burnt, buyers have ceased to complain. The higher temperature produces a harder article. Where the slightest taint of colour must be guarded against, steam drying will give an article of unapproachable colour, while the temperature, being about 100° in the drying chamber, produces a soft article.

As to economy, no doubt the utilizing of the flue gases otherwise lost comes first. If we dry pulp to about 10 per cent. dry substance, then half of the pulp production can thus be dried.

With two to three times the theoretical quantity of air entering the fireplace, 1 kg. of coal will produce, say, 25 kg. fire gases. At 300° C. and sp. heat 0·25, allowing 8 per cent. coal on beet weight, the gases per 100 kg. (220 lbs.) beets will contain $8 \times 25 \times 300 \times 0{\cdot}25 = 15{,}000$ calories.

To evaporate 1 kg. (2·2 lbs.) water, if the pulp leaves the presses at 25° C., we need $606{\cdot}5 + 0{\cdot}305 \times 100 - 25 = 612$ calories. The gases will thus contain enough heat to evaporate $\frac{15000}{612}$, about 24·5 kg. water (54 lbs.), which quantity is to be evaporated per 100 kg. (220 lbs.) of beets, when the pressed pulp contains 10 per cent. dry substance and half is dried.

Comparing the three ways with each other, we will presume that 1 lb. beets gives 1 lb. of fresh pulp, which is to be pressed for ensilaging to 8 per cent. dry substance, or dried to 86 per cent. dry substance.



Sectional Elevation of the Huillard Dryer.

100 lbs. fresh pulp at 5 per cent. dry substance.

	For ensilaging	For drying: By flue gases: Ensilaged Lbs. 50	For drying: By flue gases: Dried Lbs. 50	For drying: By steam	For drying: By fire gases from special generators
Pressed to dry substance	Per cent. 8	Per cent. 8	Per cent. 10	Per cent. 16	Per cent. 12
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Weight	62·5	31·25	25	31	42
Water pressed out	37·5	18·75	25	69	58
Gives dry pulp at 86 per cent. dry substance	—	—	2·9	5·8	5·8
To be evaporated	—	—	22·1	25·2	36·2

As to the coal required, the following may be of use :—

	By flue gases.	By steam.	By fire gases from special generators.
For drying	0	—	60 to 65 per cent. dry pulp.
Coal used, total energy included.	—	65 to 70 per cent. dry pulp.	—
Extra H.P. needed.	50 H.P. for 200 tons beet.	115 H.P. for 600 tons beet.	100 H.P. for 750 tons beet.
Temperature in drying space	300°C. to 230°C. (572°F. to 446°F.)	about 100°C. (212°F.)	600 to 1000°C. (1112°F. to 1832°F.)

The H.P. required for the flue gas system is required for an exhaust pump, which draws the gases through a tower (see figure of Huillard drying tower), and for an elevator which elevates the pulp to be dried. In Italy, where coal is very expensive, several Huillard towers (built by Huillard, Suresnes, France) dry a part of the pulp with every success.

The use of pulp as firing material being out of the question, we see the beet sugar factories all condemned to coal consumption. Thus, the special firegrates needed to fire wet bagasse have no use here, and the type of boiler is also different.

On these subjects we hope to say something later on, when treating on the steam consumption in the factory.

The large amount of lime used, and the necessity of carbonatation, justifies the equipment of lime kilns. Before we treat this important subject, we will refer to our *fabrication* diagram, and thus see that before the lime is added the raw juice must be :—

(*a.*) Strained
(*b.*) Measured
(*c.*) Heated.

The *straining* is fully justified. Fragments of cossettes have the chance of getting into the pipelines when the cell for fresh cossettes is being filled with raw juice from beneath, in which case no sieve is there to hold them back. The writer has seen masses of them in the heating tubes, hindering the transmission of heat. Besides, on coming into contact with lime, they will form viscous compounds which tend to hinder filtration. Special contrivances are therefore built in the pipeline which leads to the measuring tank. These consist of fine metal sieves, kept clean by revolving brushes.

The measuring tank must draw off the raw juice contained in the fresh cossettes cell, which means not only in the cell itself, but also in the so-called dead space. This dead space, under the sieves and in the stand pipe, is estimated at 5 per cent. when injectors, and 10 per cent. of the cell content when heaters are used.

Thus, if we fill 55 kg. (121 lbs.) cossettes per 1 hl. (22 gallons) cell contents, these will occupy $\frac{55}{1{\cdot}09}$ = about 50 litres (11 gallons) space, leaving 50 litres (11 gallons) space for juice.

For a 65 hl. (1,430 gallons) cell we should have to draw $65\times 50+\frac{5}{100}\times 65 = 35{\cdot}75$ hl. (786 gallons), about 36 to 37 hl. (814 gallons) juice with injectors, and $65\times 50+\frac{10}{100}\times 65 = 39$ hl. (858 gallons) juice in case of heaters.

In the first case, we draw per 3575 kg. (7865 lbs.) cossettes 36 to 37 hl. (814 gallons), or 100 to 103 litres (22·66 gallons) per 100 kg. (220 lbs.) cossettes. In the second case, we draw 109 to 111 litres (27·4 gallons) per 100 kg. (220 lbs.) cossettes.* In both cases we need a tank measuring about 42 hl. (924 gallons), which should be round to avoid corners (as frequently scum must be washed away). A double set will be beneficial for the regular heat transmission in the heaters. The measuring is best checked by means of an overflow, as the measured juice also serves as a basis for introduced saccharose, in comparison with the sugar in cossettes, and as basis to figure out the weight of beet. The ingress and egress are best constructed in one opening at the bottom.

The raw juice, whose temperature on arriving in the measuring tank is 30° C. (86° F.) to 18° C. (64° F.) (colder towards the end of the campaign, when frost sets in) needs a more energetic treatment in order to produce thin juice, than does raw cane juice. Where the cane juice, after proper heating, receives about 0·35 per cent. on cane weight in raw sugar factories, 1 per cent. in factories using single carbonatation, and 1½ per cent. in those cane sugar factories which are equipped with double carbonatation in order to produce granulated,

* The smaller dead space in case of injectors thus proves to be another advantage above heaters.

experience has finally brought the dose of lime for raw beet juice to $2\frac{1}{2}$ to $3\frac{1}{2}$ per cent. on weight of beets.

The heating frees the raw beet juice from some solid substance, chiefly albumen, but the main object of heating the raw juice to 70° C. (158° F.) to 80° C. (176° F.) is to prepare it for the following stations.

Though repeated trials have been made using only small doses of lime and maintaining a low temperature, the best way to gain a clear thin juice in the quickest possible manner (speed is beneficial when working with sugar solutions) is to add the lime, either dry or in the form of lime milk to the warm raw juice (70° C. to 80° C.—158° F. to 176° F.) and carbonate the limed juice separately.

As regards the heaters, I need not tread on ground English manufacturers are familiar with, but I will briefly point out their capacity and number.

Taking 20° C. (68° F.) as the average temperature* at which the juice arrives at the measuring tank, and 80° C. (176° F.) as the maximum temperature of the juice when forwarded to the lime mixers, the heating is best divided thus: the surplus heat from the last body of the evaporator, about 65° C. (149° F.) in temperature will, in most cases, be able to bring up the temperature from 20° C. (68° F.) to 50° C. (122° F.). The rise from 50° C. (122° F.) to 80° C. (176° F.) is best accomplished by taking juice vapour from the first body of 104° C. (220° F.) in temperature. For both we would design a set of three rapid heaters, of which set two heaters are able to effect the rise in temperature. Each of them must be so connected that it can be closed off and cleaned.

To figure out the heating surface, we may take 6 to 8 as a fair transmission coefficient,† while the velocity of the juice, of $4\frac{1}{2}$ to 6 ft. per second, also tends to cause less incrustation in the tubes. Like the bodies of the evaporators, they also need proper ammonia tubes, and their juice spaces should have an exit for scums.

Of the two methods for adding lime we should choose the dry process.

As the liming of the raw juice, simple as it is, is in reality the basis of good crystallizable thin juice, and the stations which follow, carbonatation tanks and filters, are closely connected with it, some space devoted to the subject in our next paper will make clear the special requirements of the designers.

We regret to record the death of Dr. H. Winter, sometime chief chemist to Messrs. Fraser, Eaton & Co., of Java, and the author of a number of interesting articles on sugar chemistry.

---

* Of course, this holds good for the unchanged form of battery. With reforced juice heating, the measuring tank receives juice of 60° C. (140° F.).

† Calories transmitted per 1 sq. metre (1 sq. yard) per minute for 1° C. temperature difference.

JAMAICA.

The Sugar Experiment Station's Report for the years 1908, 1909, 1910.

The report of the work done at the Sugar Experiment Station, Kingston, Jamaica, from 1908 to 1910 inclusive, under the supervision of Mr. H. H. Cousins, M.A., F.C.S., has recently been published in a bulky pamphlet of 135 pages.

It is prefaced by a few words explaining the constitution and working of this comparatively new venture. By the passing of a special law in 1903, the Jamaican Legislature appropriated the Imperial grant of £10,000 in aid of the sugar industry for the purpose of establishing and maintaining a Sugar Experiment Station. A scheme was drawn up in 1904 and a superintendent of field experiments and a chemical assistant were tentatively appointed. The working machinery of the enterprise was gradually got together, and the buildings and equipment were completed and in active operation before the close of the year 1904-05. The scheme included a sugar laboratory, a fermentation laboratory, and an experimental distillery, the three being provided at a total cost of £2000; while £1000 was allocated for testing new appliances in estate distilleries, and the provision of laboratories and testing outfits for distilleries. The balance of £7000 was then appropriated for the annual maintenance of the Station for a period of five years ending April, 1910. The Board of Agriculture at first took control of the new Station; but in 1908 an Advisory Committee, drawn from the planters, was formed to control the operations of the Station, whereupon the Board transferred its functions to the new governing body, which will henceforth be responsible for the carrying on of the experimental work, subject to funds being available.

With the exhaustion of the Imperial grant, it became necessary to seek financial assistance from the Legislature; and accordingly this body was petitioned by the Governor last year to provide an annual sum of £1200 a year, so as to maintain the Experiment Station unimpaired. It was pointed out that plenty of testimony has been forthcoming as to the value of the work done for the planters throughout the Island, and that therefore it would be regrettable if this work were now to be discontinued for lack of funds. Fortunately the Legislature realized the importance of all this, and agreed to the Station being supported by the Treasury as a permanent branch of the Board of Agriculture.

The *Report* reproduces a *Memorandum* prepared by the Director of Agriculture, Mr. Cousins, epitomising the work of the Station during its first five years. From it we glean that the Station was not popular at first, and had considerable difficulties to overcome in gaining the confidence of the planters and in getting at the essential problems of

the industry which vary remarkably in different localities. For no two estates in Jamaica are strictly comparable, and it was therefore necessary to multiply local trials of manuring, new canes and distillery processes in order to arrive at reliable conclusions. The record of these trials fills the bulk of the *Report* under review.

To grapple with these problems, it was necessary to have a Head Station where the preliminary investigations could be carried out, and then to test the various procedures on as many estates as possible all over the island. The plan of operations evolved and the results obtained were briefly as follows:—

1. *Manurial Experiments on Estates*:—These were designed to test in a simple manner under actual estate conditions the combination of manures calculated to give the best financial return and also to check the general conclusions as to manuring that can be drawn from soil analyses. Since 1903 these plots have been established on 77 estates, including 12 for the current year. The Superintendent, Mr. Murray, has taken a great deal of trouble in attending to these plots, and has secured efficient help and co-operation from most of the leading planters.

One financial result accruing from these experiments has been the proof that the application of lime on many cane soils will give a return of £2 to £8 per acre. Hundreds of acres of canes have been limed to advantage as a result of these experiments.

It has also been shown that on many soils phosphates are not required, and the planters can be saved the waste of money resultant from the use of mixed commercial manures that always contain a large proportion of this ingredient. Nitrogen and potash manures have generally shown themselves effective, and in a season of normal rainfall to be profitable applications.

In dry years, manures have frequently failed to yield a profit and the station results have tended to lead planters to be more cautious in the use of purchased manures on estates where dry seasons are frequent.

2. *Varietal Experiments on Estates.*—This work involved a critical study of 100 varieties of cane at the Experiment Station before the best canes could be selected for estate trials. The trials on estates likewise required expert supervision to give safe indications, and the Station has in the end succeeded in making an impression on the cane fields of the island by demonstrating:—

(*a.*) that *B. 208* is a valuable cane for general planting. Returns of from 15 to 100 per cent. in excess of the White Transparent were recorded on various estates. Indeed, on several estates this seedling gave a clear profit of £4 per acre over the older cane;

(*b.*) that *B. 147* is a valuable drought-resisting cane in deep stiff soils; and

(*c.*) that *D. 625* is a valuable cane.

A large increase in the area of seedling canes in Jamaica is expected as a result of these trials.

3. *Work at the Experiment Station.*—During the five years under review 400,000 tops of selected canes have been sent out to the fields. Of the original collection of 100 varieties three only now remain as first class canes. But in the meantime many thousands of other seedlings have been raised and 140 selected varieties are now being tested. Of these, four or five are reported to be remarkably fine and of proved stamina. The best seedlings are the result of an effort made in 1902 to cross the White Transparent with some canes of larger tonnage. The best of these have shown themselves highly resistant to drought, and capable of yielding 6 tons of sugar to the acre.

The experiment station has now 12 acres of canes under trial, and during the next few years some results of fundamental value to the sugar industry should be obtained from a systematic prosecution of the experiments. If the value of the crop of the Island be placed at £200,000, then an increase of only 5 per cent. in the efficiency of production as the result of the work of the station would repay annually the total cost of the enterprise from its initiation in 1904. Actually, however, Mr. Cousins is confident that the results of the work if continued will be greatly in excess of a 5 per cent. improvement, and that a continuation of the experiments and demonstrations is certain to yield financial result that will fully justify the cost to the State.

4. *Distillery Work.*—The two fermentation chemists, Messrs. Allan and Ashby, have in succession investigated the problems of the fermentation of rum. Mr. Allan was able from a study of a large number of samples of materials and rums, to lay down the general basis of rum production and to indicate the nature of the flavour of Jamaica rum. Mr. Ashby has isolated yeast and acid-producing bacteria and investigated their action in the wash. He has selected certain yeasts of high efficiency, and has sent them out to estates in a state of pure culture. In most cases the results obtained in the various still-houses have been most satisfactory. It is evident that in this direction the Laboratory can be of real practical service to the distilleries of the island, and this work should be pushed. Through the agency of the experimental distillery, the yield of rum obtainable from washes of various compositions with pure culture of yeasts of different types has been determined.

Fifty-five distillers have attended the Laboratory for special courses of instruction, and in many cases a marked improvement in their management on the estates has resulted. The necessity for greater intelligence and knowledge of fermentation among the distillers is greater than would at first be imagined. The value of rum is now greater than its equivalent in sugar, and more money is made or lost in the distillery than in the boiling house in many cases. The Station and Laboratory have been in constant touch with many

estates and a large amount of work of a confidential nature has been carried out in this way.

The High Ether Experiment at Hampden has been continued over four crops, and the product has been sold at 7s. to 8s. a gallon, as against an average of about 3s. 6d. for the ordinary make. It has been shown that the blending value of a rum can be increased four-fold by this process, as compared with the ordinary process of fermentation.

The Station has equipped four estate laboratories for chemical control, and fifty estates have been supplied with apparatus and appliances for controlling the acidity in their distilleries; this control has now been established as an important point in distillery work. In the Sugar Laboratory, apart from research and the testing of canes, some 3628 estate samples of juices, syrups, massecuites, sugars, molasses, rums, rum colourings, dead washes, and miscellaneous samples have been dealt with; at 10s. per sample, this represents an equivalent of £1800 in free analyses for the estates.

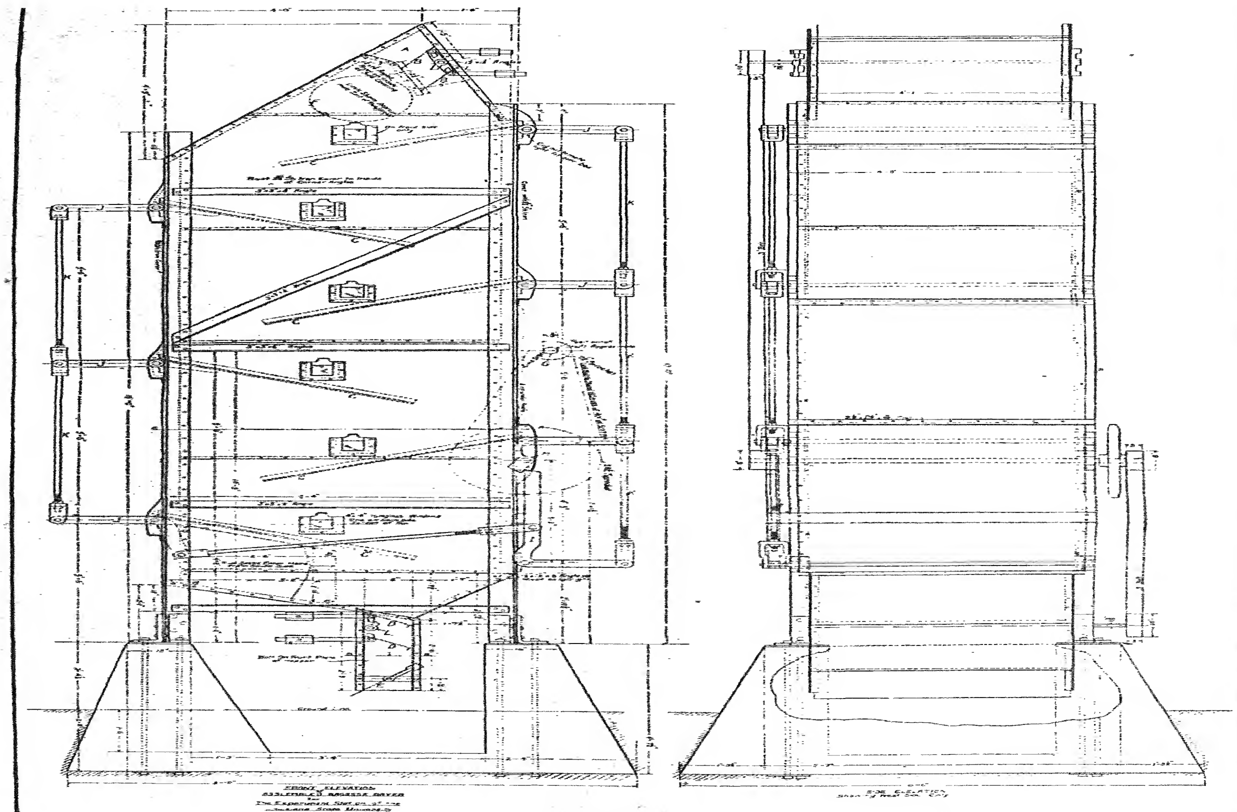
The value of the *Report*, we may state in conclusion, is enhanced by a number of excellent illustrations from photos taken by Mr. Cousins and Mr. P. W. Murray, the Superintendent of Field Experiments, showing types of cane growth, field views, and one or two factory scenes.

BAGASSE DRYING.*

Some months ago we were only able to give a brief and rather incomplete account of the experiments on the desiccation of fuel bagasse, by utilizing the waste smoke-stack heat, which have been conducted by Mr. Kerr at the Louisiana State University (this *Jl.*, 1911, 163-164). Now, however, full details have come to hand in a Bulletin which, indeed, is quite a complete treatise on the subject of bagasse drying. Although these investigations more particularly concern Louisiana factories, which turn out a bagasse with a high moisture content, say not less than 50 per cent., nevertheless they are of much general interest.

How moisture reduces the heat value.—In giving some idea of the effect of the moisture in reducing the heat value of a bagasse, a material having a water content of 52 per cent. is assumed. This means that for every lb. of bagasse there will be 0·48 lb. of dry matter, and 0·52 lb. of water. From various calorimetric tests made on Louisiana bagasse, an average heat value of 8360 B.T.U. has been found. Hence the gross heat generated will be $8360 \times 0{\cdot}48 = 4012{\cdot}8$ B.T.U. However, not all of this heat is available for producing steam in the boiler; some of it is required to convert the 0·52 lbs. of

*Derived from a paper compiled by E. W. Kerr and H. A. Nadler, and published by the Agricultural Experiment Station of the Louisiana State University, as Bulletin No. 128, 1911.



BAGASSE DRYER

water into steam at the temperature of the stack, which temperature we will assume to be 500° F. The heat thus required will be 0·52 [212 — 70 + 956 + 0·5 (500 — 212)] = 651 B.T.U. The net heat theoretically available for steam production is therefore 4012·8 — 651 = 3361·8 B.T.U. per lb. of bagasse as fired. Thus it will be seen that 651 B.T.U., out of that generated, must be used in converting the moisture in each lb. of bagasse into steam in the furnace before the bagasse fibre can be burned. This heat is about 16 per cent. In other words, 16 per cent. of the heat generated is required to evaporate the moisture in the bagasse. It is evident that the greater the moisture content, the greater this loss will be.

Heat required to dry Bagasse.—As proof of the possibility of drying bagasse by means of the waste gases, a bagasse is assumed with 52 per cent. of moisture, the net heat value of which, as just shown, is 3361·8 B.T.U. per lb. This heat is available for producing steam, but, as is well known, a considerable portion of it will be lost in the gases passing up the stack, by radiation, etc. The ratio of the heat absorbed by the water in the boiler to that supplied to the boiler is termed efficiency. A safe value for efficiency may be taken as 0·60—that is, 60 per cent. of the heat supplied to the boiler is actually absorbed, the remaining 40 per cent. being lost through the stack by radiation, etc. For radiation and other unknown losses, 10 per cent. may be assumed to be a liberal allowance, leaving 30 per cent. as the heat contained in the flue gases per lb. of bagasse burned. 30 per cent. of 3361·8 B.T.U. is 1008 B.T.U. It has already been shown that the evaporation of moisture in one lb. of bagasse with 52 per cent. moisture requires only 610 B.T.U. In other words, there is more than enough heat in the flue gases to evaporate all the moisture in the bagasse. Under the conditions considered above, the efficiency of a drying machine would have to be only $\frac{610}{1008} = 0{\cdot}60$ in order to remove all the moisture. It would seem, therefore, that i should be possible to secure a considerable increase in the fuel value of bagasse by thus utilizing the waste heat from the smoke-stack in a well-designed drier.

Methods of Drying Bagasse.—When drying bagasse by means of the waste flue gases, there are two possible methods: (1) the direct, in which the gases come in contact with the wet bagasse, thus evaporating the moisture; and (2) the indirect, in which the hot gases are first used to heat air, which is mixed with the bagasse, in place of the gases. Of these two methods the former is the more desirable, on account of its cheapness, but in applying it account must be taken of the degree of saturation that may be expected for an ordinary case, and of the temperature that must be attained to before the moisture of the bagasse can supersaturate the gases. Assuming a bagasse with 51 per cent. of moisture, and 9 per cent. of sugars and non-sugars, from

the table previously published (*Bulletin*, 117, of the La. State University, page 112), the moisture formed on the combustion of 1 lb. of bagasse is 0·28 lb., so that there will be: free moisture, 0·51 lb., moisture of formation, 0·28 lb., total moisture, 0·79, and total carbon, 0·215 lb. With an air supply of 100 per cent., in excess of that theoretically necessary for complete combustion, no CO being formed, the products of combustion for each lb. of bagasse fired will consist of the following: steam, 0·79 lb., air, 2·48 lb., CO_2, 0·79 lb., nitrogen, 1·92 lb. Here it will be noted that there is only 0·79 lb. of water to a total of 5·19 lbs. of gases. Should the temperature of these gases be reduced to, say, 200° F., the 2·48 lbs. of air alone would carry about $0·68 \times 2·48 = 1·68$ lbs. of water, more than twice the weight actually present. At this temperature the 1·92 lbs. of nitrogen would have a moisture-carrying capacity of about 5·18 lbs. and the 0·79 lb. of CO_2 would carry about 1·37 lbs. It would thus seem that the total moisture-carrying capacity of the gases from each lb. of bagasse fired would be $1·68 + 5·18 + 1·37 = 8·23$ lbs. of moisture, when, in fact, there is only 0·79 lb. of moisture to be carried off. In other words, it would seem that there is no possibility of moisture being deposited at this temperature. Calculation shows, moreover, that the temperature of these gases could be reduced to something like 150° F. before the 0·79 lb. of moisture would be sufficient to supersaturate the gases, and thus cause moisture to be deposited on the incoming bagasse.

Design of the Drier.—When it was decided to experiment with the direct method of drying, there was some question as to the possibility of bringing the flue gases, which have a temperature of about 500° F., into contact with the bagasse without setting it on fire. On investigation, it was, however, found that the bagasse could remain for 12 minutes in contact with the gases without burning, and as there is no necessity for the bagasse to remain in contact with the gases for so long as this, there need be little fear from this source. The general construction of the drier is shown in the figure. It is a rectangular sheet steel box, about 4×6 ft., and 20 ft. high on a framework of angle-irons. The bagasse was elevated to the top of the drier, where it entered at A. The smoke-stack gases entered at the bottom of the drier through the diamond-shaped opening marked a, b, c, d, and therefore passed through in a direction opposite to that of the bagasse. The bagasse entering the drier at (A) passes first one and then the other of two mechanically operated counter-weighted doors (B). These doors, which were opened by means of the revolving arm (L), shown in the drawing, were arranged so that one of them is always closed, thus insuring a minimum leakage of air to the interior of the drier. After passing these doors, the bagasse falls upon the first of the inclined shelves (C), sliding from this one to each of the others in turn, until the bottom is reached and passing mechanically operated

doors (D) similar to, and for the same purpose, as those at the top. In order to insure a progressive movement of the bagasse on the shelves (C), these shelves are given a slight shaking motion. The shelves are securely riveted to the cast arms (J) which are fulcrumed on shafts, alternately, on opposite sides of the drier. The shaking motion is produced from the revolving arm (H) through the bell crank lever (I) and rods (K). It will be noted that the rods (K) are supplied with long threads and lock nuts in order that the angle of the vibrating shelves may be varied, thus permitting control of the time during which the bagasse moves from top to bottom. The motion of the machine is derived from the shaft (G) by means of a sprocket chain. The method of driving the shafts (L and L-1) is clearly shown in the side elevation. The machine actually constructed differed from the drawing in that sprocket chains were used in all cases instead of belts. The bagasse upon reaching the bottom is caught in large galvanized buckets and elevated to an especially arranged hopper on the Dutch oven of the furnace in which dried bagasse was burned. Two of these buckets are used, and the hand-operated door (E) is used to divert the bagasse into first one and then the other of the buckets. By means of a sliding door in the bottom of the main bagasse carrier, bagasse can be fed to the 18 in. auxiliary carrier at any desired rate. The bagasse was then elevated to the top of the drier (A) by the auxiliary conveyor which consisted of a sheet-iron trough with an ordinary drag carrier. The products of combustion are drawn through the drier by means of the 55 in. fan shown in the diagram. The gases leaving the boiler rise through the uptake, enter a horizontal flue $27\frac{1}{2}$ in. square, and pass to the point (B), then downward into the bottom of the drier, and thence up through the drier into the fan. The gases leave the drier at the opening indicated by the dotted circle near the top of the drier. The gases, after passing through the fan, are discharged a short distance above the roof. The relative position of fan and dryer may be seen clearly in the drawing. Thus, it will be found, the fan produces not only the necessary movement of gases through the drier, but the draught necessary for operating the furnace itself. The fan when running at 400 revs. per min. produces a draught of $1\frac{3}{8}$ in. of water in the suction of the fan. The boiler tested was one of a battery of three served by a single stack. A damper was therefore placed in the flue, so that when operating the drier and fan the test boiler could be cut off from the stack. Another damper was provided in the flue between the boiler and the drier and near the drier.

Cost of Installation.—Together with the fan, and other accessories, exclusive of the engine, the drier cost about \$1,000. From figures obtained through reliable sources, a drying plant of this type for a factory of 1,000 tons per 24 hours capacity should cost between \$5,000 and \$6,000, and the operation should not require more than one extra

man, the only attendance being required for starting and stopping, or in case of emergency.

Experiments with the Drier.—A number of experiments were carried out, and in these the evaporative test was the general method by which the data were obtained. The water evaporated per lb. of wet bagasse was determined by the evaporative test, and compared with similar data obtained in the same manner with undried bagasse as fuel. Thus, the advantages due to drying were shown. It was necessary to weigh the feed water and the bagasse in all the tests. A Stirling boiler with 1,000 sq. ft. of heating surface, with its own special feed-water pump was used; also an oil pump fitted with a governor, so that experiments should be made in which oil and bagasse were burned together in the same furnace.

As to the bagasse furnace, the area of the grate for most of the tests was 20 sq. ft.—that is, 4 ft. long and 5 ft. wide—the bridge wall being placed over the back end of the Gordon hollow blast bars. The weight of this bridge wall did not rest on the bars, a small arch being used to carry it to the side of the furnace. This arrangement was used in order that the area of grate might be reduced to the desired amount and still use the 5 ft. 6 in. bars. The bagasse, which had been previously weighed, was fed through a temporary hopper, the regular hopper being closed at such times. The temporary hopper was also provided with a door so that it could be closed when tests were not being conducted. The furnace was arranged so that it could be operated with forced draught or natural draught at will, the hollow blast bars being connected up with a Sturtevant blower.

Results of Experiments.—From 40 evaporative tests, it was found that there was an average evaporation of 1·63 lbs. of water from and at 212° F. per lb. of the wet bagasse used, with 53·5 per cent. of moisture; and 2·53 lbs. average evaporation per lb. of dried bagasse, with 45·4 per cent. of moisture. By means of a calculation, we find that with these moisture contents, the weight of the bagasse after passing the drier is 85·1 per cent. of that entering the drier. The increase in fuel value due to drying is therefore:

$$100\ \frac{2{\cdot}53 \times 0{\cdot}851 - 1{\cdot}63}{1{\cdot}63} = 32{\cdot}1 \text{ per cent.}$$

From this result it is an easy matter to calculate the fuel oil equivalent of this increase, and from it the money value. The average equivalent evaporation from and at 212° F. per lb. of wet bagasse was found to be 1·63 lbs. By drying, an additional 32·1 per cent. of this = 0·52 lbs. can be evaporated by each lb. of bagasse. The average mill extraction during the tests was 74 per cent., so that the weight of bagasse was 26 per cent. of the weight of cane ground. For each ton of cane ground there was therefore 520 lbs. of wet bagasse. The additional water evaporated from and at 212° F. per ton of cane ground, due to drying, would therefore be 520 × 0·52 = 270 lbs.

Assuming a factory of 1000 tons per 24 hours capacity, and a total grinding of, say, 60,000 tons per season, there will be a total increase of $270 \times 60,000 = 16,200,000$ lbs. of water evaporated. One lb. of average crude oil will evaporate 14 lbs. of water from and at 212° F.; the total oil saved per season will therefore be $16,200,000 \div 14 = 1,157,143$ lbs., equal to 154,285 gallons at 7·5 lbs. per gallon. This gives $154,285 \div 60,000 = 2·57$ gallons of oil per ton of cane, which is saved due to drying. Assuming a barrel of oil to hold 42 gallons, the total oil saved would be 3,673 barrels, which, at $1·00 per barrel, would have a money value of $3,673.

METHODS OF ANALYSIS AND CHEMICAL CONTROL FOR USE IN CANE SUGAR FACTORIES.*

By Guilford L. Spencer.

(Continued from page 558.)

ESTIMATION OF THE PRODUCTS IN PROCESS OF MANUFACTURE.

Stock-taking.—The laboratory records should include the dimensions and capacities of all tanks, pans, crystallizers, mixers, etc., in the factory. Each piece of apparatus should bear a suitable mark for identification.

At the close of a run the chemist, accompanied by his assistants, should rapidly pass through the factory and measure and sample all material in process. At the same time the head pan-boiler should indicate with chalk the depth of massecuite in each pan and note its character. Beginning two or three days before the close of a run, the head crystallizer men should record the "inches out" for each crystallizer as soon as it is filled.

In measuring the juice and syrup in the tanks it is usually easier to measure the depth of the empty space from the top of the tank, or, in other words, the "inches out," rather than the depth of the liquor. The stock notes should always distinctly indicate the quantity of material in the vessel, and, if empty, that such is the case. There must be an entry for each container.

Samples should be drawn, representing each class of material in stock. The laboratory records will show the analyses of the massecuites, so these need not be sampled.

From these data the quantity of materials of all kinds in stock, at a given hour, may readily be calculated. All stock data and calculations should be entered in a book to facilitate the work of estimating

* Abridged from "Methods of Analysis and Chemical Control for use in the Factories of the Cuban-American Sugar Company." Arranged by Guilford L. Spencer. Published by the Cuban-American Sugar Company, New York, 1911. Price $1.00.

and detecting errors. It is preferable that all calculations be made in the book itself.

It is sometimes more convenient to make the stock estimates a little in advance or after the close of the run, in order to take advantage of a shut-down. In the one case the cane ground from the hour of stock-taking to the end of the run is carried as "stock," and the sugar it will produce is estimated on a basis of the yield for the rest of the period. In the other case the estimated yield from the cane ground from the end of the run to the shut-down is to be deducted from the total.

ESTIMATION OF THE SUGAR IN PROCESS.—The sugar in process in the raw juice may be estimated on a basis of the "sucrose retained" in a previous run, or if such data are not at hand, the "retention" may be estimated at 88 per cent. As the quantity of raw juice in stock is small, an over or under estimate here will introduce a very small error. Likewise the yield from clarified juice may be estimated at a somewhat higher rate, and that from syrup at a still higher rate, as these materials have already undergone a part of the manufacturing process. When first massecuite is made without boiling in molasses, its sugar yield may be estimated upon the above basis.

When molasses is "boiled-in," the yield of sugar from the massecuites may be estimated by means of the following formula: Let $x=$ percentage yield of commercial sugar from the massecuite; $B=$degree Brix of the massecuite; $P=$polarization of the massecuite; $p=$polarization of the commercial sugar; $S=$percentage of solids in the commercial sugar; $M=$coefficient of purity of the final molasses:—

Then
$$x = \frac{100\,P - B\,M}{p - \frac{S\,M}{100}}$$

This method of calculation gives the yield of sugar with sufficient accuracy. The results would be accurate if true Brix, polarizations, and purities could be used, provided no solids are removed from the molasses in the processes of manufacture other than in the sugars.

The above formula is also used in calculating the yield of sugar from the molasses.

It will be noted in these methods that the yield includes all of the sugar presumed to be available, as of one grade. If more classes of sugar than one are made, their relative proportions must be ascertained from the experience of the factory and the calculated yield apportioned accordingly, figuring each class to the average polarization of that grade of sugar.

ESTIMATION OF THE MOLASSES IN PROCESS.—The molasses in process may be estimated from the total solids (Brix), or the sucrose remaining after the deduction of these in the products. It is

customary and preferable to base the estimate upon the total solids, since the direct polarization of low purity materials, and in fact of practically all sugar-house products, is too low, and the variation from the true polarization is the greatest in the very low grade materials. Further, in estimates based upon the solids, tables are available to facilitate the figuring.

The weight of solids (Brix) in materials in process of manufacture *minus* the solids in the sugar that it is estimated these will produce, leaves the solids in the molasses in process. This number divided by the degree Brix assumed for the molasses in process, pointing off for percentage, gives the weight of molasses. The sucrose is calculated from the degree Brix and the assumed purity. It is not customary to allow for the air occluded by the molasses, but to divide the weight of molasses by the weight of the gallon (air-free) as deduced from the degree Brix. This introduces an error which remains fairly constant during the crop. In fact in all molasses measurements the error due to occluded air enters. Commercial molasses includes this air.

The molasses flowing from the storage tank into the tank-cars carries more or less air with it, according to the position of the discharge pipe and the density of the molasses, hence the tank-car measurement is usually slightly larger than that in the tank. The measurement in the car, however, is the one to be used whenever possible, as it is the commercial number. So far as the sucrose control of the factory is concerned, this is provided for if the molasses is weighed in the cars. Unfortunately railway track arrangements often preclude weighing the molasses.

RUN CALCULATIONS.—The following example illustrates the methods of making a few of the run calculations and is based upon the data in the tabulation:—

Material.	Temperature °C.	Volume, cub. ft.	Brix or Solids.	Sucrose, per cent.	Purity.
Juice, Raw (none in stock).					
Scums (none in stock).					
Defecated	75	4221	19·14	16·62	86·26
Syrup	50	2257	56·44	50·00	88·58
Molasses	50	5067	78·54	43·53	55·42
First massecuite	60	2772	92·28	71·28	77·31
Second massecuite	55	6780	94·09	58·12	61·77
Final molasses, estimated, *see* Résumé	..	..	82·5	28·05	34·00
		Gals.			
Final molasses, yard tank....	..	82,143	82·5	28·05	34·00
Sugar	..	..	98·5	95·8	..

Juice.—The juice is measured at a high temperature, hence a volume correction must be applied. Use Gerlach's table for the expansion of sugar solutions, interpolating to approximate the temperature and concentration of the juice.

A 15 per cent. solution contracts from 10290 to 10031, in volume, in cooling from 75-17½° C., or 2·6 per cent. ∴ 4221 × (100—2·6)÷100=2111 cub. ft. the net volume of juice. A cub. ft. of juice at 19·14° Brix weighs 67·305 lbs.:—

4111 × 67·305 = 276,691 lbs. juice.
276,691 × 0·1914 = 52·959 lbs. Brix solids.
276,691 × 0·1662 = 45,986 lbs. sucrose.

From previous experience of the factory this juice should yield 93 per cent. (retention number) of its sucrose in the manufacture. ∴ 93 ÷ 0·958 × 45,986 = 44,609 lbs. commercial sugar. This is a conservative estimate.

Syrup.—An approximate and sufficiently accurate method of correcting for temperature and estimating the weight of the syrup, massecuite and molasses is illustrated in this calculation :

Brix correction at 50° C. = 2·75. ∴ 56·44 – 2·75 = 53·69, the Brix of the syrup at 50° C. A cub. ft. of syrup at this density weighs 78·15 lbs. ∴ 78·15 × 2257 = 176,385 lbs., the weight of the syrup.

176,385 × 0·5644 = 99,552 lbs. Brix solids.
176,385 × 0·50 = 88,192 lbs. sucrose.

Based upon 94 per cent. estimated retention number the yield of sugar is 86,516 lbs.

Molasses.—The factory used a "two-massecuite" method, so there is but one grade of molasses that re-enters the manufacture.

The weight as calculated by the method for syrup is 438,954 lbs.

438,954 × 0·7854 = 344,754 lbs. Brix solids.
438,954 × 0·4353 = 191,076 lbs. sucrose.

The estimated yield of sugar is figured by substitution in the formula given under Estimation of the Sugar in Process as follows :—

$$x = \frac{100P - BM}{p - \frac{SM}{100}} = 4353 - (78{\cdot}54 \times 34) \div (95{\cdot}8 - (34 \times 0{\cdot}985) = 27{\cdot}0 \text{ per cent.},$$

438,954 × 0·27 = 118,518 lbs. sugar.

First Massecuite.—The temperature correction table does not extend beyond 75° Brix. Using the correction for this density, the error is probably within the limits of accuracy of the sampling and measuring.

By the method used for the syrup and the correction number for 75° Brix, the weight of massecuite is 255,273 lbs.

$$255{,}273 \times 0{\cdot}9228 = 235{,}566 \text{ lbs. Brix solids.}$$
$$255{,}273 \times 0{\cdot}7128 = 181{,}956 \text{ lbs. sucrose.}$$

By the commercial sugar formula as applied for molasses, the yield of sugar to be expected is 64·04 per cent. or 163,477 lbs.

Second Massecuite.—Weight of the material as estimated by the method used for first massecuite is 631,082 lbs., and the estimated yield of sugar by the commercial sugar formula is 41·93 per cent., 264,613 lbs.

$$631{,}082 \times 0{\cdot}9409 = 593{,}785 \text{ lbs. Brix solids.}$$
$$631{,}082 \times 0{\cdot}5812 = 366{,}784 \text{ lbs. sucrose.}$$

The figures should be tabulated as below. It is advisable to use the left-hand page of the stock-book for the data and the right-hand page for the calculations. Check calculations or entries should be made in red ink:

STOCK RÉSUMÉ.

Materials in Process.	Brix.	Sucrose.	Commercial Sugar.		
			Weight.	Solids.	Sucrose.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Juice	52,959	45,986	44,609		
Syrup	99,552	88,192	86,516		
Molasses	344,754	191,076	118,518	667,567	649,268
First massecuite	235,566	181,956	163,477		
Second massecuite	593,785	366,784	264,613		
Total in process.	1,326,616	873,994	677,733	667,567	649,268
Final molasses—					
In yard tank	....	195,056	....	....	....
In tank cars	....	78,694	....	....	....
Shipped	....	1,304,596	....	....	....
Sugar packed	....	....	23,167,586	....	22,194,547
To date	....	....	23,845,319	....	22,843,815
To previous run, inclusive	....	....	19,639,446	....	18,814,589
For run	....	....	4,205,873	....	4,029,226

Molasses in process = (solids in process, 1,326,616 — solids in the estimated sugar in process, 667,567) ÷ Brix of the final molasses, 0·825 = 798,847 lbs. A gallon of molasses of 82·5° Brix weighs 11·94 lbs.

$$\therefore\ 798{,}847 \div 11{\cdot}94 = 66{,}905 \text{ gallons;}$$
$$\text{sucrose} = 798{,}847 \times 9{\cdot}2805 = 224{,}076 \text{ lbs.}$$

Résumé of molasses figures:—

	Weight. Lbs.		Volume. Gallons.		Sucrose content. Lbs.
Molasses in process	798,847	..	66,905	..	224,076
,, on hand	976,631	..	82,143	..	273,350
,, shipped	4,531,639	..	384,514	..	1,304,596
,, to date	6,307,117		533,562		1,802,422
,, to previous run, inclusive	5,209,973	..	438,589	..	1,460,917
,, of this run........	1,097,144		94,973		341,505

The analysis of the molasses on hand *i.e.*, in the large yard-tank, is more or less a matter of estimate, since this material is of variable composition and is constantly flowing into the tank while the centrifugals are in operation, and it is drawn off at frequent intervals from the bottom of the tank for shipment. Owing to its great vicosity the molasses is never thoroughly mixed and of homogeneous composition. The superintendent must be guided by local conditions in estimating this analysis, *e.g.* from the analysis of the molasses from each crystallizer he knows that the purity averages 33°, and from the shipment samples, that the Brix is 87°, and from these two numbers he may estimate the analysis. The error so introduced is small if shipments are frequent, as the average analysis of these is used for the greater part of this product.

In the calculation of the yield of sugar and the retention number, the figures of the above tables are used. These and the remaining calculations of the run report are simple and it is unnecessary to give them here. The figures of the table are from an actual run of a factory at a time when it was customary to produce molasses of moderate density. At present the factories produce very dense molasses that is difficult to properly sample.

In houses using the Spanish pound, it is convenient to figure first in avoirdupois weight and then convert the results into Spanish weight. This makes the tables in English weights available.

Direct polarizations are to be used in the yield calculations.

Miscellaneous Calculations.

Saturation.—Correct the measured volume of the water for expansion by the customary tables, reducing it to the corresponding volume at 4° C., or if within the range of the table further on, use the weight at the temperature of measurement. The weight of a cub. ft. of water at 4° C. is 62·427 lbs.

$$\text{Per cent. saturation} = \frac{62{\cdot}427 \times \text{cub. ft. water at } 4^\circ \text{ C.} \times 100}{\text{Weight of cane in pounds}}.$$

Dilution.—(Brix of normal juice—Brix of diluted juice)÷Brix of normal juice × 100 = dilution per cent. diluted juice; diluted juice extraction per cent. cane × dilution per cent. diluted juice ÷ 100 = dilution per cent. cane.

Mill Extraction.—(1) When not saturating: Mill extraction per cent. cane = weight of juice ÷ weight of cane × 100.

(2) Mill extraction when saturating: Mill extraction per cent. cane = per cent. mill extraction including dilution — dilution per cent. cane.

Weight of diluted juice ÷ weight of cane × 100 = mill extraction including dilution per cent. cane.

Mill extraction including dilution per cent. cane × dilution per cent. diluted juice ÷ 100 = dilution per cent. cane.

(3) Mill extraction, sucrose in juice per cent. sucrose in cane. In calculating this number the sum of the sucrose in the bagasse and that in the juice (sucrose) in the cane is divided into the sucrose per cent. juice. The accuracy of this number is affected by the dilution of the juice by water other than that used for the saturation.

There are two methods of estimating the weight of the juice from its volume after deducting from the entrained air and the milk-of-lime added to it:

(1) Correct for expansion or contraction of the juice for temperatures above or below 17·5° C. by Gerlach's table, showing the volumes of sugar solutions at different temperatures, or the correction may be determined experimentally. The weight of a cub. ft. of water at 17·5° C., 62·341 lbs., multiplied by the specific gravity of the juice corresponding to its degree Brix at 17·5° C., gives the weight of a cub. ft. of the juice.

(2) This method is illustrated in the following example:

Degree Brix of the juice at 17·5° C. = 20·0
Temperature of the measurement = 27·0° C.

The degree Brix at 27° C., applying the number in Gerlach's table for the correction of readings on the Brix scale for temperature, is 20·0—0·65=19·35, and the corresponding specific gravity is 1·08039 The weight of a cub. ft. of water at 27° C. is 62·21 lbs., as shown in the table below, therefore 62·21 × 1·08039 = 67·21 lbs., the weight of a cub. ft. of the juice at the temperature of the measurement.

Table showing the Weight of a Cubic Foot of Water at Various Temperatures.

Temp. ° C.	Weight of 1 cub. ft.	Temp. ° C.	Weight of 1 cub. ft.	Temp. ° C.	Weight of 1 cub. ft.	Temp. ° C.	Weight of 1 cub. ft.
4	62·427	19	62·33	24	62·26	29	62·18
16	62·26	20	62·32	25	62·24	30	62·16
17	62·36	21	62·30	26	62·23	31	62·14
17½	62·35	22	62·29	27	62·21		
18	62·34	23	62·28	28	62·19		

Bagasse.—When saturation is not employed: Per cent. bagasse = 100—per cent mill extraction. When saturation is employed: Per cent. bagasse = (100 + per cent. saturation) − per cent. diluted juice.

These percentages are in terms of the weight of the cane.

Efficiency of Saturation.—(1) Ascertain the weight of fibre, juice, and water entering and leaving the mills.

The juice remaining in the bagasse per cent. water entering the mills $= a$; the water remaining in the bagasse per cent. water entering the mills $= b$; $100b \div a =$ efficiency coefficient of the saturation, *i.e.*, the degree to which the water has mixed with the juice in the cane. (After I. H. Morse.)

(2) The following method by E. E. Hartmann is preferable to (1) when more accurate results are desired.

Let A = bagasse from the second mill;

B = ,, ,, third ,,

Diffusion water = the quantity of water, assuming complete diffusion with the juice in the bagasse, that would bring the percentage of sucrose in A to that in B.

Then

$$\frac{(\text{Lbs. sucrose in } A \times \text{juice per cent. } B) - (\text{sucrose per cent. } B \times \text{lbs. juice in } A)}{\text{Sucrose per cent. } B} = \text{diffusion water (lbs.)};$$

Coefficient of diffusion (coefficient of efficiency) = diffusion water (lbs.) ÷ saturation water (lbs.) × 100.

When double saturation is practised, *i.e.*, the bagasse from the first mill is saturated with the thin-juice from the last mill, the diffusion water is calculated from the bagasse data of the second and third mills, and also from similar data of the first and second mills, and these numbers are added to ascertain the total diffusion water.

This method is applicable with any combination of mills.

Efficiency of Mill Work.—A number indicating the efficiency of mill work and taking into account the fibre content of the cane, is derived by the following formula of Noël Deerr. The percentages refer to the analysis of the bagasse: per cent. residual juice in the bagasse ÷ (per cent. fibre × specific gravity of residual juice) = efficiency number.

M. de Sornay, of Mauritius, has been presented by the Association des Chimistes de Sucrerie et de Distillerie de France et des Colonies with a gold medal for his valuable articles entitled "Use of Phosphoric Acid in the Cane Sugar Factory" (this *Jl.*, 1910, 414), and "Action of Iodine on the Non-sugars of the Cane in the Presence of Sulphuric Acid" (this *Jl.*, 1911, 276).

DIRECT DETERMINATION OF SUCROSE IN ALL PRODUCTS CONTAINING MORE OR LESS REDUCING SUGARS. DESTRUCTION OF REDUCING SUGARS.

By H. Pellet and P. Lemeland.

As far back as 1850, Dunbrunfaut first demonstrated the use of alkalis for the destruction of reducing substances. Later, Otto employed alkalis for destroying reducing substances such as may be present in beet factory products, but in this case only small amounts were being dealt with.

One of us (Pellet, *Bulletin, France*, 1897-98,

pointed out the use of alkalis for the same purpose, giving, however, directions for the application of the method to the analysis of cane factory products containing considerable proportions of reducing sugars.

A. Jolles (*Zeitsch. Unters. Nahr. Genussm.*, 1910, *20*, 631, and this *Jl.*, 1911, *13*, 109) similarly utilized the reaction for the analysis of products that contain reducing sugars only in small amount, such as 2 to 3 per cent.

One of us (P. Lemeland, *Jl. Pharm. Chim.*, 1910, *2*, 298, and this *Jl.*, 1910, *12*, 638) published an article on the procedure to be followed for the destruction of the reducing sugars in presence of sucrose, employing alkali, but also adding manganese dioxide. The method of working is summarized as follows: (1) A solution of the product to be analysed is made. (2) A certain volume of this solution is placed in a 100 c.c. flask with 0·5 grm. of powdered manganese dioxide. (3) The flask is placed in a boiling water-bath, and a mixture of 30 c.c. of hydrogen peroxide (12 vol.) and 2 c.c. of sodium hydroxide (36° Bé.), which proportions are correct for the destruction of 1·0 grm. of reducing sugars, is made. (4) Pour the mixture little by little into the flask, agitating meanwhile, and making the operation last 35 to 45 minutes. (5) Cool, neutralize the excess of alkali by acetic acid, add sufficient basic lead acetate for defecation, complete the volume to 100 c.c., mix, filter, and polarize in the 200 or 400 mm. tube. (6) Calculate the polarization on the weight of material taken, and express the result as the percentage of sugar on the sample. After the treatment the liquid contains no reducing sugars, and it is well decolorized.

By this method, it was not found possible to use the mixture of sodium hydroxide and hydrogen peroxide for an undefecated cane molasses. It was necessary to have recourse to defecation by means of mercuric nitrate, prepared according to the directions of Dr. Patein.

This being so, we have endeavoured to ascertain whether it was not possible to reduce the length of the operation, and to do without the

presence of the operator during the heating. After a number of experiments, we have finally adopted the following method: (1) Make a solution of the cane molasses that will contain at most 5 per cent. of reducing sugars. (For example, suppose the molasses contains 40 per cent. of sucrose, and 15 per cent. of reducing sugars, 30 grms. in 100 c.c., or 60 grms. in 200 c.c., should be used.) (2) Measure 50 c.c. of this solution into a 300 c.c. flask, add 7·5 c.c. of sodium hydroxide (36° Bé.), then 75 c.c. of hydrogen peroxide (12 vols.), and 60 c.c. of water. (3) Mix and place the flask in a boiling water-bath for 20 minutes. (4) Cool, neutralize the remaining alkalinity fairly exactly with acetic acid, and defecate with basic lead acetate solution (36° Bé.), the amount of which necessary will be found to vary from 15 to 40 c.c., according to the weight of the material taken, the amount of reducing sugars destroyed, and the impurities initially contained in the liquid. (5) Complete the volume to 300 c.c., mix well and filter. First polarize directly in the 200 or 400 tube. Then 50 c.c. of the filtered liquid may be taken, 1 c.c. of glacial acetic acid added to it, the volume completed to 55 c.c., and after mixing a second polarization made, account being taken of the dilution. This is done because the second polarization is often a little different to the first, in which the liquid is alkaline. If a difference is observed, then the second, or acid polarization, should be used. Finally, the percentage of sucrose is calculated on the solution, and then on the sample. From special experiments, we have found that there is no need to take into consideration the lead precipitate formed.

Experience with the method has convinced us that with it very concordant results on the same sample are obtainable, and, further, that the figures are very close to those obtained by inversion, when special precautions for as great accuracy as possible are made. We have also observed that the volume of sodium hydroxide (36° Bé.) to be added is about three times the weight of the reducing sugars contained in the 50 c.c. of liquid taken. If, however, the amount of reducing sugars is less than 0·5 to 0·6, the fixed minimum volume of 7·5 c.c. of sodium hydroxide (36° Bé.) should still be used.

Again we have noticed that if 7·5 c.c. of sodium hydroxide (36°Bé.) is made to react upon a solution of sucrose, *in absence of reducing sugars*, for 20 minutes in the boiling water-bath, in presence of hydrogen peroxide, there is a slight destruction of the sucrose, but that under these conditions the alkalinity remains the same. When there are reducing sugars present, a large part of the alkalinity is neutralized by the acids formed during their destruction, so that the solution does not retain its initial degree of alkalinity. By, however, treating 5 to 10 grms. of sucrose in presence of 2·5 grms. of reducing sugars with 7·5 c.c. of sodium hydroxide (36° Bé.) in the way described above, *no destruction whatever of the sucrose can be detected.*

If treatment with alkali is properly carried out, the defecated liquid no longer contains any trace of optically-active reducing sugars, although there may be present reducing bodies that no longer have any rotatory power, and therefore cannot affect the result. During our experiments we observed that the loss of rotatory power is much more rapid than that of the reducing power.

At times the action of the hydrogen peroxide when commencing heating may give rise to the formation of froth. It is then sufficient simply to withdraw the flask from the water-bath for a few seconds, and agitate. On then replacing the flask, reheating may be continued without danger.

By working according to this new method the advantages obtainable are: (1) A process allowing of the heating of several flasks at the same time without special supervision. (2) The duration of heating is reduced. (3) Suppression of the manganese dioxide. (4) Well decolorized liquids. (5) And, lastly, the direct determina- of the sucrose.

The process is applicable to beet products that, for some reason or other, contain reducing sugars and raffinose. Raffinose is not affected by the heating with sodium hydroxide and hydrogen peroxide, so that if the treated liquid be used the percentage of sucrose may be verified by the inversion method, and the special formulae for the calculation of the raffinose applied. It is, of course, necessary to ascertain the constant corresponding to the dilution of the solution and the particular procedure followed for the inversion.

CUBA.

The Final Figures of the 1910-11 Cotton Crop.

Messrs. Guma & Mejer, of Havana, have just published the final figures of the Cuban sugar crop for 1910-11. As will be seen below, the total amount of the sugar produced in the 16 provinces comes to 10,384,157 sacks, or 1,483,450 long tons (seven sacks to the ton). The estimates of last December anticipated a crop of 1,748,714 tons, so it will be seen that the actual amount is a good way below expectations. Cienfuegos, with 27 centrals, heads the list of provinces as regards tonnage; but the palm for merit must be awarded to Gibara y Puerto Padre, whose five centrals turned out no less than 182,286 tons of sugar. These five include the renowned Chaparra, which stands supreme with a crop of 64,808 tons, its nearest rival being Nipe Bay in the same province with 41,419 tons to its credit. It is to be noted that the British-owned Stewart Central in Jucaro is well to the front among individual factory results with a crop of 30,045 tons.

Provinces.	Centrals.	Sacks.	Tons. (2240 lbs.)
Habana	25 ..	962,907 ..	137,558
Matanzas	26 ..	1,213,751 ..	173,393
Cardenas..	23 ..	1,301,174 ..	185,882
Cienfuegos..	27 ..	1,850,390 ..	264,341
Sagua	22 ..	800,382 ..	114,340
Caibarien	13 ..	857,436 ..	122,491
Guantanamo	9 ..	479,690 ..	68,441
Cuba	4 ..	134,677 ..	19,240
Manzanillo	9 ..	571,093 ..	81,585
Santa Cruz del Sur	1 ..	127,915 ..	18,274
Nuevitas	2 ..	175,144 ..	25,021
Jucaro	2 ..	352,908 ..	50,415
Gibara y Puerto Padre ..	5 ..	1,276,004 ..	182,286
Zaza	3 ..	99,044 ..	14,149
Trinidad..	1 ..	57,984 ..	8,283
Central Jatibonico	1 ..	124,258 ..	17,751
	173	10,384,157	1,483,450

FRANCE.

THE SUGAR CAMPAIGN OF 1910-11.

The official figures relating to the French sugar campaign for the twelve months ending August 31st last have recently been issued.

From these we glean that the number of active beet factories was 239 as compared with 244 in 1909.

The official figures of acreage are not yet public, but it has been calculated that there were under cultivation 228,700 hectares (564,889 acres) as compared with 223,885 hectares (552,996 acres) in 1909. This shows a steady increase in sowings since 1906, but is a long way behind the 276,331 hectares of 1905 or 312,465 hectares of 1901.

The quantity of roots worked up is unofficially estimated at 5,479,700 metric tons, as compared with 6,246,844 metric tons, the official quantity in 1909. This works out at almost 24 metric tons to the hectare (9½ long tons to the acre) as compared with 27·9 tons in 1909.

The production of sugar was 650,493 tons (expressed as refined), compared with 733,900 tons in 1909-10, which gives a yield of sugar in the roots of 11·87 per cent., as compared with 11·75 in 1909. The reduced output was, therefore, due solely to the poor harvest of roots per hectare.

The consumption of sugar expressed as refined amounted to 688,261 metric tons, equal to 17·5 kg. (38·5 lbs.) per head of the population. In 1902-3 the amount was only 371,119 tons.

GERMANY.

THE SUGAR CAMPAIGN OF 1910-11.

The sugar campaign of 1910-11 in Germany has been noteworthy in three respects—the increase in the acreage under cultivation, the excellent crop, and finally, the high sugar content of the roots harvested.

The area under beets was variously estimated, but the best authorities place it at 474,003 hectares (1,170,787 acres), an increase of 3·6 per cent. over the acreage of 1909, which latter again was roughly a 3 per cent. increase over the 1908 area. The greatest area previous to 1910 was in 1901, but the figures for the last campaign have surpassed all records.

The cultivation was carried on in the Spring with such regularity that the beets came up a full fortnight earlier than in the previous year. This advantage was slightly affected by cold weather in May, but still was maintained through the season and contributed no little to the good results. Moreover, the conditions during September and October were very favourable to growth, the fine, warm weather neutralizing the effects of a rather damp summer, so that a high yield in sugar was ultimately attained. The rainfall during the season was ample and fell at the right time, while the sunshine was somewhat below the average, especially from July to September, but this did not appear to affect the development of the roots.

The quantity of beets worked up came to 15,753,402 metric tons (of 2,200 lbs.), as compared with 12,892,068 tons in 1909. The increase in roots was therefore no less than 22·2 per cent., while that in area was only 3·6 per cent. This works out at 33·2 metric tons per hectare (13·21 long tons per acre), as compared with 28·2 metric tons to the hectare in 1909 (11·21 long tons to the acre). This has been thrice exceeded in former years, but the average for the last decade is only 29·4 metric tons, so that this year's yield may be considered highly satisfactory.

There were 354 factories at work in 1910, as compared with 356 in 1909.

The net production in sugar from beets, expressed in raw, came to 2,496,788 metric tons, as compared with 1,947,509 tons in 1909. Calculated on the beets worked up, this gives a yield in sugar of 15·85 per cent. on weight of roots, as compared with 15·11 per cent. in 1909. The hectare thus yielded 5·28 metric tons of sugar (equal to 2 tons 2 cwt. to the acre). It may be added that the total production of sugar, including that extracted from molasses, reached the figure of 2,574,116 metric tons as compared with 2,037,396 tons in 1909-10.

The inland consumption of Germany during 1910-11 amounted to 146,038 metric tons (expressed as raw), as compared with 116,237 tons in 1909-10. Taking the population to be 65,600,000, this works out at 21 kg. (or 46 lbs.) per head.

PUBLICATIONS RECEIVED.

Rapport de Mission aux Iles Hawaiiennes au Sujet de l'Industrie du Sucre de Canne et de la Culture de la Canne à Sucre. By Auguste de Villèle. Published by Th. Drouhet, Fils. St. Denis. 1911.

M. A. de Villèle, a well-known sugar cane specialist, was deputed by a certain number of Mauritian planters to report upon the present state of the sugar industry in the Hawaiian Islands, which latter are not only foremost in methods of culture and manufacture, but also possess very similar climatic and geological characteristics to Mauritius. The outcome of the visit is a book full of valuable data, upon the compilation of which M. de Villèle is to be heartily congratulated. The up-to-date plant and methods of manufacture, of chemical control, and of cane culture now in vogue in the Hawaiian Islands, are all adequately reported upon, chiefly, of course from the standpoint of the Mauritius technologist, and a number of drawings of plant are given. Everyone knows the difficulty of collecting information of this kind; but the writer has done his work in a manner that should earn the appreciation of his colleagues. It may be remarked that it seems a matter for surprise and regret that the number of subscribers towards the cost of the visit (given at the end of the volume) should have been so small, and that the benefit of such a report should not have been more generally recognized amongst the planters and manufacturers of the island. Perhaps, however, now, with its publication, the value of M. de Villèle's report will be better appreciated. It is impossible to give anything like an adequate review of the great amount of matter contained in the book, and we can only pick out here and there, in the section dealing with manufacture, some facts that seem to be of general interest.

Transport of Cane.

In the Hawaiian Islands, the railway, flume, and aerial ropeway are all used as modes of transport, but the first of these is most in vogue. Certain managers of estates were requested by the Planters' Association to report upon methods of transport, and they arrived at the following figures, expressing the cost of transporting the cane necessary for the production of one ton of sugar:—

	Shillings.
By flume alone	28·9
,, wire rope	27·8
,, traction and flume	27·5
,, cartage and flume	27·3
,, railroad	25·5
,, permanent railway	20·9
,, portable rail	18·5

Unloading.

By using mechanical unloading appliances, not only is economy in labour effected, but regular feeding of the mills is ensured, a point of importance for efficient sugar extraction. Of these different systems, two are most employed, viz., the continuous rake and the curved fork. By means of these mechanical unloaders one man can send 1000 tons of cane in 12 hours to the mills.

Preparation of the Cane.

All Hawaiian mills treat the cane preparatory to milling by crushers, and a few, about 3 per cent., possess shredders. Moreover, quite a third of the factories, those most up-to-date, now use a cane cutter before the defibrator, so that the cane arrives at the cylinder of the first mill in a regular and uniform layer.

Hydraulic Pressure.

American engineers exert hydraulic pressure on the upper cylinder, and this method is stated to give satisfaction to the planters in the Hawaiian Islands. Crude petroleum oil, costing only about 1d. per gallon, is used in this plant.

Imbibition and Extraction.

Imbibition of the bagasse is applied within the very variable limits of 10 to 49 on the diluted juice, using generally the last washings from the presses. The figures for the extraction are given as 93 to 96. In evidence of the superiority of Hawaiian methods of sugar extraction over those of other countries, taking Java as example, the author quotes the following figures:

	Hawaiian Islands.	Java.
Sugar in the cane	14·03	12·42
Fibre in the cane	12·37	11·48
Purity of the clarified juice	93·55	85·00
Sugar obtained, per cent. on the sugar in the juice	92·20	88·80
Sugar obtained, per cent. on sugar in the cane	86·25	88·50
Purity of the molasses	34·51	34·0
Sugar packed, per cent. on sugar in the cane	11·96	10·10
Tons of cane, per ton of sugar	8·16	9·60

Weighing of Juice.

In most of the factories the juice is weighed, and this method is considered necessary for proper control. It is superior to measuring, which is regarded as inexact, on account of air, bagasse particles, &c., contained in the juice.

Liming the Juice.

As refining sugars only are made, the juice coming from the weighing machines is not sulphured. After being run into large tanks,

generally of a capacity of about 4730 gall., in the bottom of which is placed a pipe conveying compressed air to ensure proper admixture with the milk-of-lime arriving by another pipe, the juice goes to a modified Deming apparatus.

Decantation and Filtration.

Settling takes 35 to 40 minutes. For the cloudy juice, sand filters are employed. The filtration and washing of the scum is carefully carried out in the presses, the sugar content of the cake averaging, in 1909, 2·25 per cent.

Evaporation, Boiling, Machining, and Crystallizing.

It is stated that quadruple effects are most used. From the last vessel the syrup is drawn off at 30 to 31° Bé., and goes to measuring tanks from which the pans can be fed in a systematic manner. The after-products, which are returned to the pan at the end of boiling, are placed in similar measuring tanks near by, and these are provided with a steam coil, which maintains the after product at a temperature of 80°C. Sometimes when boiling after-products a small amount of caustic soda, previously dissolved in water, is drawn into the pan, the object being to decompose the calcium salts, with the formation of those of sodium, which are less viscous. First massecuites remain 24 hours. and seconds 8 to 10 days. All the machines are on the Weston system, and are generally placed immediately below the crystallizers. On leaving the machines the sugar usually goes to a Hersey hot-air drier.

Chemical Control, Cane Culture, Fertilization, &c.

The methods of chemical control are, in general, those recently published by the Hawaiian Chemists' Association (this *Jl.*, 1911, 19-25). Other portions of the book deal with the culture of the cane, its plantation, varieties, manuring, harvesting, and the parasites attacking it; and finally with the fertilization of the soil.

SUGAR BEET: SOME FACTS AND SOME ILLUSIONS. A Study in Rural Therapeutics. By "Home Counties" (J. W. Robertson Scott). With 100 illustrations. Crown 8vo., 424 pages. Cloth 6s. net. London, Horace Cox, "Field" Office.*

This work is a most careful and comprehensive study of a burning question of the day. Is it possible or not to start a beet sugar industry in the United Kingdom? The author has been at great pains to ascertain the real facts, and has spent some time on the Continent to see things with his own eyes in the centre of the beet sugar industry. The authorities he quotes are endless, and as a rule unimpeachable;

* This volume is referred to at further length on another page under "Sugar Beet and its indirect Benefits."

but he is indeed so anxious to let the reader hear both sides that the latter is left uncertain whether after all Mr. Scott himself is not sitting on the fence. Certainly to some of us he may appear to attach undue weight to the opinions of certain opponents of the home beet sugar industry. But this is only a slight blemish in an otherwise excellent work; and having regard to the fact that Mr. Scott's interest in the subject is comparatively recent, he can hardly be expected to offer any pronounced opinion. That his sympathies lie in the direction of making a start in the new agriculture is however clear, and those who wish to take such steps will find much to encourage them in Mr. Scott's book. A word of praise is due to the very excellent illustrations that adorn the volume; many of these seem to have been taken specially for this work, while others have appeared already in sundry publications, or are from blocks lent by interested parties. Indeed we do not appear ever to have come across so well illustrated a general work on the beet sugar industry.

PEEPS AT INDUSTRIES: SUGAR. By Edith A. Browne. Crown 8vo., 88 pp., and 24 illustrations from photographs. London: A. & C. Black. 1s. 6d. net.

One of Messrs. Black's characteristic books for the young. The writer of its pages has gleaned most of her material from a visit to Demerara. Those engaged in the sugar industry, who have children and wish to initiate them into the *modus operandi* of the family business, could not do better than get the youngsters a copy.

CATALOGUE DES OUVRAGES SPECIAUX DE LANGUE FRANÇAISE CONCERNANT LE SUCRE ET L'INDUSTRIE SUCRIÈRE COMPOSANT LA BIBLIOTHEQUE DE LEWIS S. WARE. By A. J. Seulier, Librarian. A. Davy, 52, Rue Madame, Paris.

A large demy 8vo. volume of 340 pp., containing the list of the French works on sugar and the sugar industry belonging to Mr. Lewis Ware, the editor of the American quarterly, *The Sugar Beet*. If we are to assume that Mr. Ware has been equally successful in accumulating works in other languages, he must have about the largest library of sugar publications that any individual possesses.

News comes to hand that the Hawaiian Sugar Planters' Association is establishing a Sub-Experiment Station at Waipahu, some 15 or 20 miles out of Honolulu, and that probably Mr. Hamilton P. Agee will be delegated to take charge of it.

Correspondence.

PARTICIPATION CONTRACTS.

To the Editor of the "International Sugar Journal."

Dear Sir,—I would once more draw your readers' attention to participation contracts and the benefit the farmers derive from them, as set forth in the annual account of Vierverlaten factory in Holland. In 1910-11, 77 million kg. beets were sliced, harvested from 2,767 hectares, making 27,825 kg. per hectare, or 11·1 tons per acre. The following form the chief data:—

Saccharose	16·87 per cent.
Sugar per hectare ..	4,694 kg. or 38 cwt. per acre.
1st raw sugar.. ..	11,578,900 kg. at fl. 12·47 per 100 kg.
2nd raw sugar .. .	478,400 kg. at fl. 8·96 ,,
Molasses	1,299,200 kg.

Per Metric Ton Beets.

Expenditure.	Fl.	Income.	Fl.
Beets	14·57	Sugar	19·83
Working expenses..	3·10	Molasses	0·542
Net gain	4·69*	Pulp	1·63
		Limecake	0·013
		Lime	0·007
		Property	0·018
		Interest	0·32
	Fl. 22·36		Fl. 22·36

Of this gain, fl. 95,000 (£7,916) was paid as participation profit to those farmers who had chosen that form of contract.

The price paid for beets to the farmers was:—

1. Telquel price, fl. 12 per metric ton.
2. Participation price . .. .fl. 12·53
   Plus extra participation bonus.. 1·57

Total .. .. .. fl. 14·10

or £1. 3s. 6d. per metric ton.

The dividend paid to shareholders on fl. 950,000 capital was 15 per cent.

For 1911-12, 2,800 hectares are sown, of which 98 per cent. are on participation contracts.

Very truly yours,

Ed. Koppeschaar.

* 7s. 10d. per ton.

ABSTRACTS, SCIENTIFIC AND TECHNICAL.*

Evaporation under Pressure without the Use of a Condenser. *By P. Kestner. Bulletin, France, 1911, 28, 989-1004.*

According to the author there is no doubt that evaporation in the sugar factory is undergoing an evolution that is rapidly leading to the complete suppression of condensation. It is pointed out that the first stage of this development has actually been accomplished, since in all modern (Continental) factories the proportion of steam going to the condensers is extremely small, and the condenser might be entirely abolished without the equilibrium scarcely being affected. As to the second stage of the evolution, comprising the concentration of the juice to 60-65° Brix with steam *entirely under pressure*, this, it is thought, will follow in the near future. If the scheme of (beetroot) factories, constructed within recent years, be examined it will be seen in the majority of them that the proportion of steam going to the condensers has gradually decreased. Some years ago, in sucreries provided with pre-evaporators it was 10 kilograms (on the roots sliced); whereas now in several factories it has been decreased to 4 kilograms, and even less. The consumption of steam in these factories has been diminished in the same proportion; and all schemes of steam distribution in the factory end in the conclusion that the nearer the complete suppression of condensation is approached, the less is the amount of steam consumed. Karl Abraham, in his well-known work,† has presented in a very clear and concise form a number of different propositions, all pointing to the fact that the maximum economy is obtainable by the entire suppression of the condenser, *i.e.*, by working completely under pressure. What so far has hindered this evolution is the fear of the result of high temperatures on the juice. In order to apply the principle of concentration *à effet multiple*, and thus obtain steam from the last vessel that can be used for heating and re-heating in the factory, it is necessary that the first vessels should work under high pressure and correspondingly high temperatures. In those apparatus that work with a weak initial pressure, *i.e.*, using exhaust steam, the juices are appreciably coloured; and, although the destruction of sugar does not necessarily follow the appearance of colour, an increase of colour is always a cause for apprehension, and has had an unfavourable effect towards the development of working under pressure. In place of those film evaporators, in which the juice takes one minute to pass through, the author has constructed apparatus for concentrating mangrove and other extracts, in which the duration has been reduced to only 15 seconds. Still, for sugar liquors, and for a temperature of 125° C., it is considered

† "Die Dampfwirtschaft in der Zuckerfabrik," published by Schallehn and Wollbrück, Magdeburg.

that with a duration of 30 to 60 seconds no appreciable coloration can take place. The shorter of these durations is accomplished by evaporation on the *descendage* principle, and the longer by working with *grimpage*, provided the tubes are at least 7 m. (23 ft.) long, and 25-30 mm. (1 to $1\frac{1}{5}$ in.) in diam. The apparatus in which the juice remains only 15 seconds has found application in cane sugar factories, in which the juices are much more sensitive to heat than those obtained from the beet. The first plant for concentration entirely under pressure has been installed in the Tirlement Sucrerie-Raffinerie, Belgium, and consists of a double effect under pressure, the first vessel of which is heated by steam at 2 kilograms per sq. cm. (about 28 lbs. per sq. in.) pressure; while the steam from the second vessel, having a temperature of 116° C., is used for heating and re-heating in the factory and refinery. This installation was used throughout almost the entire campaign, and, as the ordinary vacuum evaporators were in operation a portion of the time, it was possible to compare the two. With the new system the syrups were quite free of colour; whereas in the old one the coloration was very marked; which results confirm those previously obtained with Kestner apparatus used only as pre-evaporators, and not as at Tirlemont with the whole apparatus under pressure. Moreover, it was found that, not only were the syrups of fine quality, but the consumption of steam was less.

Experiments with a Kestner Pre-Evaporator. *By Em. Saillard. Suppl. Circ. hebd. Syndic. fabr. Sucre, No. 1155, 1911.*

In the Noyelles-sur-Escaut factory, in which the author's experiments were carried out, 300-350 tons of roots are sliced per day, and the juice is purified by double carbonatation. The evaporating station consists of a triple effect, provided with a Kestner pre-evaporator, having a heating surface of 50·39 cub. m. (542 sq. ft.), and tubes 7 m. (23 ft.) long; while the vessels of the triple have a surface of 205, 137, and 113 sq. m. (2207, 1474, and 1215 sq. ft.) respectively. After carbonatation and filtration, the juice is passed through a pre-heater, supplied with steam from the Kestner, and then it is passed through the Kestner pre-evaporator itself. The graining installation consists of four pans. Of these, the first, of a capacity of 190 hectol. (4180 gall.), is heated by six coils, one receiving direct steam, one steam from the first vessel of the effect, and the remainder steam from the Kestner pre-evaporator. The second and third pans, of a capacity of 190 and 70 hectol. (4180 and 1540 galls.) respectively, are heated similarly by direct, first vessel, and pre-evaporator steam; while the fourth pan is reserved for the after-product work, and it is supplied with a mixture of exhaust and pre-evaporator steam. White sugar and exhausted molasses are made in this factory, the second product being dissolved in the carbonatated juice. As the result of his deter-

minations on the coefficient of heat transmission for the Kestner pre-evaporator, the author obtained the following figures:—

Length of the tests	3¼ hours.
Density of the juice entering the Kestner apparatus..	12·2° Brix.
Density of the juice leaving ,, ,, ..	11·7° ,,
Temperature of the juice in the measuring tank	91·6° C.
Juice drawn from the Kestner..	55·846 litres.
Water evaporated	4·816 ,,
Kilograms of water per hour	1486
Temperature of juice entering the pre-heater	85·39 °C.
,, ,, entering the Kestner apparatus..	99·65 °C.
,, ,, leaving ,, ,, ..	106·5 °C.
,, of the heating steam top of steam chest..	112·6 °C.
,, of the heating steam bottom ,, ,, ..	113·35 °C.
Difference of temperature between the steam entering and the juice leaving	6·8 °C.
Coefficient of transmission.. .. .. In calories per sq. metre, degrees of difference of temperature, per minute..	38·85 calories.
Coefficient of transmission.. .. .. In kilograms of water evaporated per sq. metre, degrees of difference of temperature per hour	4·29 kilograms.
Density of the hot thick-juice (syrup)	32·7° Bé.

In a previous series of experiments on the duration of evaporation, it was found that in the case of the Kestner the values are 35 to 40 seconds, and for the Pauly 108 seconds. These results are confirmed by the following experiments made with the Kestner apparatus:—

	Experiment 1.	Experiment 2.	Experiment 3.
Volume of juice entering the Kestner per minute	269 litres ..	297 litres ..	283 litres.
Volume of juice leaving the Kestner per minute	244 ,, ..	273 ,, ..	258 ,,
Capacity of the Kestner	130 ,, ..	130 ,, ..	130 ,,
Duration of the evaporation ..	32 seconds..	29 seconds..	30 seconds.

Alteration of (Beet) Thin-Juice in the Pre-Heater. *By B. P. Loukianoff. Zapiski;* through *Centr. Zuckerind.*, *1911*, *20*, *46–47.*

Opinions as to whether any change occurs when juice is passed through a pre-heater under ordinary conditions of working do not appear to be altogether unanimous. Having observed that the juices coming from the pre-heater in the Russian factory Talnoë, had increased in colour, the author was induced to carry out a number of experiments, taking especially into consideration the careful determination of the temperature, and the duration of the juice in the apparatus. The vessel used was 2 m. (6 ft. 6 in.) in diam., 3·2 m. (10 ft. 6 in.) long, and contained Witkowitsch heating tubes of

80 sq. m. (861 sq. ft. 21 sq. in.) total area. The volume of the juice was 40 hectol. (880 gall.), the temperature of the steam 138-140°C., and the pressure varied between 0·7 and 1·0 atmos. Every half-hour test samples were taken just as the juice entered the pre-heater, and immediately on leaving it. Altogether, the experiments lasted six days, and the following results were obtained:—

	Entering Pre-heater.	Leaving Pre-heater.
Pressure	—	0·92 Atms.
Brix	21·7	24·68
Sugar	20·25	22·78
Purity	93·3	92·3
Alkalinity	0·0255	0·0225
Colour (Stammer) on 100 parts of sugar	34·13	41·63
Decrease of purity	—	— 1·00
Increase of colour	—	+ 7·5

It is pointed out that these figures do not corroborate the view that the alteration of the juice in the pre-heater is so small as to be quite negligible. In addition to the factory experiments, laboratory tests with pure sugars were made in vessels of copper, iron, and glass, using temperatures between 100 and 140°C. As the result of these, and of the factory experiments, the following general conclusion is drawn: "By being heated in the pre-heater under the above-stated conditions, the juice undergoes certain changes, characterized by a decrease in the purity, and an increase in the colour. Laboratory experiments confirm the investigations made in the factory, and show that it is to the temperature that the principal rôle must be ascribed." Lastly, it is observed that the increase of colour of 7·5 on 100 parts of sugar, resulting when the juice passes through the pre-heater, if calculated on the original juice amounts to 21·9 per cent.; and that as the total increase of colour from the juice to the finished thick-juice (syrup) has been shown to amount to 46·5 per cent. on the original juice, from the pre-heater as far as the pans it will be 24·6 per cent., likewise stated in terms of the original juice.

NORMAL JUICE OF THE CANE: COMPOSITION OF THE NODES AND INTERNODES. *By H. Pellet. Bulletin, Mauritius, 1911, 2, 19-28.*

Generally by the term "normal juice" is understood the undiluted juice obtained from the first crushing, either directly, or after passing through a defibrator. According, however, to the author, such a juice in no way represents the normal juice, but is richer and purer. He points out that the relation between the juice extracted, and the juice remaining, is not constant, but depends both on the quality of the cane and the degree of crushing. It is quite an easy matter to demonstrate how the composition of the juice varies with the crushing,

and how the purity diminishes as the crushing increases, and further how between the first and last crushings there may be a difference of purity amounting to 10°. It can also easily be shown that the salts and organic substances increase in amount with the crushing, but that the reducing sugars vary little from one to the other, being sometimes higher, and at other times even lower. As the degree of crushing varies, the juice extracted will be more or less different from that in the bagasse, and it is quite impossible to establish any definite relationship. Consequently, the juice from the first crushing, whether passed through a mill alone, or a mill or defibrator, cannot be considered as the "normal juice." Proper speaking, the normal juice is the entire juice of the cane, represented by 100 less the fibre, which is the definition accepted by the Hawaiian Chemists' Association (*cf.* this *Jl.*, 1911, 19). As to the reason why the first crushing juice differs from the last, whether or not imbibition has been used, a number of causes have been suggested, amongst which may be mentioned: (1) the colloid water, or water of dehydration of the cells, does not mix with the juice; and (2) that the cells of the cane are variable in composition, those more tender, which allow their contents to escape more readily, containing the richer juice. In the author's opinion the simplest explanation is to be found in the variable composition of the cane in its different parts, especially in the nodes and internodes. As bearing this out, Beeson's analyses (*Bulletin, France*, 1895-1896, 362), showing the composition of the nodes and internodes at the top, middle, and bottom parts of the cane stalk are presented; and the conclusion drawn from these figures is that: (1) the juice of the internodes is richer and purer than that of the nodes; (2) the juice of the internodes contains more reducing sugars than that of the nodes; and (3) the internodes contain less fibre than the nodes. Since, now, the internodes are not so hard as the nodes, it is from the former that the juice will be first expressed, and the more the cane is crushed, the impurer will be the juice obtained. On the other hand, as the nodes generally contain less reducing sugars than the internodes, often the juice from the second and third crushings will contain less reducing sugars, although less impure. In resumé, the following conclusions are stated: (1) The juice of the first crushing, either alone or mixed with the juice from the defibrator, cannot be considered as the "normal juice" of the cane. (2) The normal juice of the cane is represented by 100 *minus* the weight of fibre. (3) The juice extracted from the first crushing may be used for calculating the sugar per cent. on the cane after having determined the factor by which the sugar content of the juice must be multiplied. (4) This factor decreases as the cane contains more fibre. (5) It will also decrease in proportion as the amount of juice obtained is less. (6) The more the juice is pressed, the more impure this juice will be. (7) This decrease in purity is due to the variable

composition of the different parts of the cane, the nodes, the internodes, the hard and the soft parts respectively, analyses having demonstrated that the hard parts yield less pure juice than the soft ones. (8) Lastly, in some cases the reducing sugars may be less in the second and third crushing juices, because the nodes, which are hard, often contain a juice less charged with reducing sugars than the juice of the internodes.

NOTES ON THE DETERMINATION OF ACIDS IN CANE JUICE. *By P. A. Yoder, Jl. Ind. Eng. Chem., 1911, 3, 640-646.*

With the object of obtaining an insight into the nature of the different acids existing in cane juice, the author tried each of the existing methods for the identification and determination of plant acids (*e.g.*, those of Jörgensen, Kunz, Möslinger, Schmidt and Heipe, Mutellet, von Ferentzy and Behr), but found them to work more or less unsatisfactorily, principally because none of them take into account the possible presence of aconitic acid known to be present in cane products (*cf.* Behr., *Berichte*, *10,* 351, von Lippmann, *ibid.*, *12,* 1649, and Parsons, *Amer. Chem. Jl.*, *4,* 39). He, however, has elaborated a special process, by means of which some interesting results have been obtained. Briefly stated, the procedure was as follows: The acids were converted into lead salts; then into calcium salts, which were separated into fractions by their different solubility in alcohol of increasing concentration; these various fractions were finally examined for oxalic, phosphoric, sulphuric, tartaric, malic, succinic, and aconitic acids, using recognised methods in each case. As the result of an examination of 6 litres of juice pressed from D74, D95, La. Purple, and La. Striped canes, the following figures were obtained:

Names of Acids.	Grms. of Acid per 100 c.c. of juice.
Sulphuric acid (as SO_3), total not determined	0·00051
Phosphoric acid (as P_2O_5)	0·00314
Oxalic acid	0·00004
Tartaric acid	absent
Malic acid	0·00077
Succinic acid	absent
Aconitic acid, not determined, but indications of about	0·05
Citric acid	absent
Total determined or indicated	0·05447

Commenting upon this statement of the acids of cane juice, it is pointed out that they are equivalent to 60·2 c.c. of N/1 solution; whereas the total amount of acids separated as lead salts at the commencement of the experiment corresponded to 125·1 c.c. of N/1 solution, leaving about half unaccounted for. Doubtless, it is said, half of this deficiency is acetic acid, incompletely washed out from the lead precipitate; while neither lactic acid nor tricarballylic acid

(*cf.* von Lippmann, *Berichte*, *11*, 707, and *12*, 1649) were identified. Nevertheless, it is clear that aconitic acid is the predominating acid in Louisiana cane juice; and that of the others the only ones present in appreciable amount are phosphoric and sulphuric acids. Oxalic, tartaric, succinic, citric, and malic acids are either absent, or are present in such small amount as to be of no practical significance to the manufacturer. In concluding his article, the author states that "this relatively high percentage of aconitic acid is a special characteristic of sugar cane juice and its unpurified products. The suggestion that it occasions the peculiar cane flavour in these products, however, finds no support in the taste of the purified acid, or in the odour or the taste developed on heating aconitic acid, or its salts, or mixtures of these, with sugar. . . . . The phosphoric acid is doubtless removed in part in the clarification process if the juice is limed to neutrality. . . . . With reference to the extraction of sucrose from the molasses, it would be interesting to know what are the melassigenic values of the aconitic acid and its several salts, *i.e.*, their power of preventing or facilitating the crystallization of sucrose. The high solubility of the lime salt of aconitic acid, even in a hot solution, makes it improbable that any notable quantity of the aconitic acid is removed in the clarification process in which lime is used, or that it is deposited as a scale or sediment during evaporation in the effects or the pans, unless the presence of sugars to the point of saturation materially reduces the solubility of the calcium aconitate. The aconitic acid, therefore, accumulates in the molasses, where it is usually present in extraordinary large amounts."

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E. Chartered Patent Agent, 6, Lord Street, Liverpool; 77, Market Street, Bradford; and 285, High Holborn, London.

ENGLISH.—Applications.

21204. A. Wynberg and J. N. A. Sauer. *Manufacture of sugar.* (Complete specification.) 26th September, 1911.

21808. A. Boivin. *Machines for breaking and packing sugar.* (Addition to 25246/09.) (Complete specification.) 3rd October, 1911.

22059. L. C. Reese. *Sugar.* 6th October, 1911.

22963. L. Nagel. *Machines for chopping brittle sugar bars.* 18th October, 1911.

GERMAN.—Abridgments.

237432. Edward Shaw, of Clayton Croft, Dartford Heath, Kent, England. *An apparatus for evaporating or concentrating liquids.* January 7th, 1910. In this apparatus the liquid is conveyed by means of a pump through the spiral coils of an externally heated pipe, a small interval being provided between the outer edges of a

guide worm fixed in the pipe and the internal face of the pipe, so that when the apparatus is in use the inner face of the pipe is covered with a coherent film of liquid, whereby portions of the liquid are prevented from being overheated.

237558. MASCHINENFABRIK BUCKAU A. G., of Magdeburg. *A method of producing constant vacuum in vacuum pans and evaporators.* 14th June, 1910. An exhaust turbine which is fed with the vapour from the concentrating pans in an already known manner is directly connected with the necessary pumps for producing the vacuum, so that on a change in the vacuum arising and a change in the number of revolutions of the turbine caused by such change in the vacuum, the action of the pump is so influenced that during the entire course of the boiling-down process an approximately constant vacuum is maintained.

237598. FIRM A. WAGENER, of Cüstrin-Neustadt. *A starch-washing apparatus.* 13th February, 1910. This apparatus consists of a brush cylinder with conveyor blades and so-forth, and its characteristic peculiarity is that plates which form channels when rotated are arranged on the blade shaft in such a way that the pasty substance thrown off the blades is caught on a firm support in order to be thoroughly washed with water, and finally caused to fall off such support in an inclined direction at the place where the straining or sieving surface in the brush cylinder commences.

238725. SOCIÉTÉ ANONYME DE LA RAFFINERIE A. SOMMIER, Paris. *A machine such as described in Patent No. 235617 for cutting and packing sugar.* (Patent of Addition to Patent No. 235617 of 27th October, 1909.) 7th May, 1910. This machine comprises a feeding, cutting, and packing mechanism, and has a barred grating arranged behind the continuously operating cutting mechanism, which grating receives during the forward movement of the conveyor table from the cutting mechanism, the cut cubes, and on the return of the table delivers them to another grating placed between its bars and arranged on the table itself.

UNITED KINGDOM.

IMPORTS AND EXPORTS OF SUGAR
To End of October, 1910 and 1911.

IMPORTS.

Unrefined Sugars.	1910. Tons.*	1911. Tons.*	1910. £	1911. £
Russia	93	1,599	1,190	19,210
Germany	128,940	392,238	1,661,010	4,285,339
Netherlands	13,342	16,120	161,163	232,955
Belgium	8,149	15,130	94,598	181,833
France	431	244	6,260	2,366
Austria-Hungary	45,508	41,635	595,624	423,702
Java	118,204	117,927	1,603,911	1,857,285
Philippine Islands	....	3,479	....	30,773
Cuba	96,336	3,859	1,371,633	29,610
Dutch Guiana	5,691	4,986	82,720	61,081
Hayti and San Domingo	76,546	28,013	1,078,580	305,302
Mexico	10,639	7,992	150,953	99,342
Peru	43,109	21,413	559,839	213,897
Brazil	51,284	13,405	617,420	122,449
Mauritius	39,534	47,609	570,569	515,387
British India	8,871	3,796	96,674	49,161
Straits Settlements	792	998	9,389	13,277
Br. West Indian Islands, Br. Guiana & Br. Honduras	71,457	50,780	1,045,728	686,776
Other Countries	23,419	13,735	311,981	141,395
Total Raw Sugars	742,346	784,959	10,019,242	9,274,140
Refined Sugars.				
Russia	94	80,728	1,452	1,168,030
Germany	258,744	324,803	4,086,343	4,516,675
Holland	77,146	108,174	1,263,793	1,665,553
Belgium	27,396	40,258	459,223	642,127
France	59,175	4,954	981,599	74,974
Austria-Hungary	145,091	163,962	2,391,304	2,310,067
Other Countries	80,525	23,434	1,366,412	384,665
Total Refined Sugars	648,172	746,313	10,550,126	10,762,091
Molasses	130,634	116,612	589,448	490,940
Total Imports	1,521,152	1,647,884	21,158,816	20,527,171

EXPORTS.

British Refined Sugars.	Tons.	Tons.	£	£
Denmark	3,270	3,715	47,203	46,131
Netherlands	2,593	2,411	39,574	34,304
Portugal, Azores, & Madeira	1,276	967	18,992	12,856
Italy	291	991	4,026	11,767
Canada	8,871	7,762	143,071	115,005
Other Countries	7,953	9,306	146,617	154,515
	24,254	25,152	399,483	374,578
Foreign & Colonial Sugars				
Refined and Candy	633	1,059	12,009	16,582
Unrefined	4,234	6,373	59,802	79,709
Various Mixed in Bond	75	....	1,285	....
Molasses	299	328	2,107	2,214
Total Exports	29,495	32,912	474,686	473,083

* Calculated to the nearest ton.

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1911. Tons.		1910. Tons.
Total Receipts Jan. 1st to Oct. 26th ..	1,893,031	..	1,992,020
Receipts of Refined ,, ,, ...	231	..	149
Deliveries ,, ,, ...	1,892,754	..	1,973,579
Importers' Stocks, October 25th	277	..	21,791
Total Stocks, November 1st	111,000	..	139,940
Stocks in Cuba, ,, ...	1,000	..	6,000
	1910.		1909.
Total Consumption for twelve months ..	3,350,355	..	3,257,660

CUBA.

Statement of Exports and Stocks of Sugar for 1909, 1910 and 1911.

(Tons of 2,240 lbs.)	1909. Tons.		1910. Tons.		1911. Tons.
Exports	1,407,995	..	1,692,216	..	1,408,812
Stocks	24,063	..	54,376	..	6,040
	1,432,058	..	1,746,592	..	1,414,852
Local Consumption (9 months)..	46,970	..	46,008	..	51,850
	1,479,028	..	1,792,600	..	1,466,702
Stock on 1st January (old crop)..	....	..	....	..	....
Receipts at Ports up to Sept. 30th	1,479,028		1,792,600		1,466,702

Havana, 30th September, 1911. J. Guma.—F. Mejer.

UNITED KINGDOM.

Statement of Imports, Exports, and Consumption of Sugar for Ten Months ending October 31st, 1909, 1910, 1911.

	Imports. 1909. Tons.		Imports. 1910. Tons.		Imports. 1911. Tons.	Exports (Foreign). 1909. Tons.		Exports (Foreign). 1910. Tons.		Exports (Foreign). 1911. Tons.
Refined	754,203	..	648,172	..	746,313	633	..	633	..	1,059
Raw	629,251	..	742,346	..	784,959	2,923	..	4,309	..	6,373
Molasses	136,994	..	130,634	..	116,612	256	..	299	..	328
	1,520,448		1,521,152		1,647,884	3,812		5,241		7,760

	Home Consumption. 1909. Tons.		1910. Tons.		1911. Tons.
Refined	745,753	..	638,812	..	731,401
Refined (in Bond) in the United Kingdom........	503,554	..	528,545	..	551,521
Raw	97,488	..	125,798	..	112,488
Molasses	116,527	..	120,838	..	114,605
Molasses, manufactured (in Bond) in U.K........	56,708	..	53,825	..	66,459
Total..........................	1,520,030	..	1,467,818	..	1,576,474
Less Exports of British Refined..................	28,383	..	24,254	..	25,152
	1,491,647		1,443,564		1,551,322

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, OCTOBER 1ST TO 31ST, COMPARED WITH PREVIOUS YEARS.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1911.
150,300	35,640	61,250	49,200	23,200	319,590

	1910.	1909.	1908.	1907.
Totals	524,960..	449,800..	493,860..	637,850.

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING SEPTEMBER 30TH, IN THOUSANDS OF TONS.

(Licht's Circular.)

Great Britain.	Germany.	France.	Austria-Hungary	Holland, Belgium, &c.	Total 1910-11.	Total 1909-10.	Total 1908-09.
2029	1445	801	692	251	5218	4654	4651

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1911-1912. Tons.	1910-1911. Tons.	1909-1910. Tons.	1908-1909. Tons.
Germany	1,460,000 ..	2,600,000 ..	2,033,834 ..	2,082,848
Austria	1,175,000 ..	1,538,000 ..	1,256,751 ..	1,398,588
France	575,000 ..	720,000 ..	806,405 ..	807,059
Russia	1,800,000 ..	1,140,000 ..	1,126,853 ..	1,257,387
Belgium	225,000 ..	285,000 ..	249,612 ..	258,339
Holland	240,000 ..	222,000 ..	198,456 ..	214,344
Other Countries .	500,000 ..	590,000 ..	465,000 ..	525,300
	5,975,000	8,095,000	6,136,911	6,543,865

THE

INTERNATIONAL SUGAR JOURNAL.

No. 156. DECEMBER, 1911. Vol. XIII.

☞ All communications to be addressed to the Editor, Office of "The Sugar Cane," Altrincham, near Manchester. All Advertisements to be sent direct.

☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

Cheques and Postal Orders to be made payable to NORMAN RODGER, Altrincham.

The Editor will be glad to consider any MSS. sent to him for insertion in this Journal and will endeavour to return the same if unsuitable; but he cannot undertake to be responsible for them unless a stamped addressed envelope is enclosed.

NOTES AND COMMENTS.

The Month.

Much of interest has happened since our last issue appeared that might be referred to. A change in political leadership at home and a crisis in international sugar politics have, however, the most claim on our consideration. Mr. Balfour, who has been leader of the Unionists in the House of Commons for some 20 years, and in the later years of Unionist power succeeded his uncle, the late Lord Salisbury, as Prime Minister, has taken the opportunity recently offered to him by a lull in political strife to resign his leadership and revert once more to the position of a private member. His ostensible reason for taking such a step was the state of his health, which has been an uncertain factor within recent years, and might now fail him at some critical period. Other reasons are also hinted, but while these may have added their quota to the balance it is not thought that they have had the same decisive influence. Undoubtedly his hold on his party was not latterly the same as in former years. Certain of the younger and more militant members had been disposed to chafe at his line of policy, and their formation of a club but a few months ago to establish their position as an independent factor in politics could not, to say the least, have made their leader's path any easier. Probably it is near the truth to state that Mr. Balfour is too much of a gentleman and a philosopher to lead with entire success in the present democratic age.

But he was one of the best men the Unionists have had, and his retirement is bound to be a loss to the party even though they will continue to have the benefit of his help as a private M.P.

The choosing of a successor to lead the Opposition in the House of Commons had a rather unexpected outcome. Two men, each with a considerable following, were in the running, and in the end they each voluntarily retired from the contest to avoid any chance of weakening the party by internal disputes, and a third, whose claims had hardly received any notice in the public eye, acquiesced in the unanimous request of the party to assume the leadership. Mr. Austin Chamberlain and Mr. Walter Long were the men who generously stood aside for their party's good and made way for Mr. Bonar Law, a man whose rise to influence in the counsels of his party has been so comparatively recent that in the last Unionist Government which went out of office at the end of 1905 he was not even in the Cabinet but only a Parliamentary Under-Secretary. Mr. Bonar Law is, however considered the most brilliant exponent of tariff reform that the Unionists possess at the present day, and if his speeches are not marked by the dialectical skill and subtlety that Mr. Balfour possessed, he is at any rate a very practical speaker and a master of illustrative argument. Since his promotion, he has made speeches which have exceeded expectations, even on the part of those who had the most confidence in him, and has thereby strengthened his position. It is interesting to record that one of the first noteworthy speeches he made in the House of Commons was on the Brussels Sugar Convention, when Mr. Joseph Chamberlain introduced his Bill to give effect to its provisions. Mr. Law's speech on that occasion was very favourably commented on.

The other event of importance to claim our attention has been the crisis centring round the beet sugar shortage, and the question of Russia's surplus stock. Russia, as we know, has been endeavouring to secure from the Commission at Brussels permission to increase her exportable margin of sugar by 200,000 tons. Since the meeting of the Commission on October 26th and its adjournment to the 8th of this month, to give Russia time to consider whether she would bring her legislation into line with that of other parties to the Convention as a condition of her being allowed to export freely, the supporters and the opponents of the Convention have once more taken up their cudgels in the press of this country and some interesting letters have been published, some of which are reproduced or summarized on another page. *The Times* has devoted a material amount of space to the controversy, and has contributed interesting articles of its own as well as opened its correspondence columns. On November 21st came a bombshell in the form of an announcement by Sir Edward Grey on behalf of his Government that the latter would denounce the Convention at the earliest opportunity (*i.e.*, in 1913) if Russia's demands

were not acceded to. This momentous decision has naturally thrown fresh fuel on the fire. The sugar users (apart from the refiners) are jubilant, while the dealers, the refiners, and the representatives of the sugar colonies are aghast. There are reports of deputations to be formed to interview the Foreign Secretary and protest against any such rash step being taken, but at the moment of writing nothing definite can be chronicled on this score. Meanwhile the irrepressible Mr. Lough (who, since his official connection with the present Government ceased a year or two ago, has made himself spokesman for the Anti-Bounty party in the House of Commons) has not rested content with Sir Edward Grey's bare declaration, but after some futile attempts to elicit more information at "question time," has taken steps to raise a debate on the whole question in the Commons, thinking no doubt that this will emphasize, by means of the votes of the Liberal majority, the supposed unpopularity of the Brussels Convention in this country. If he succeeds, however, it is more likely to emphasize the unpopularity of this country in Continental circles, where we have no doubt some strong language is being expressed over Great Britain's breach of diplomatic faith in inducing Continental States to abolish their bounties and then leaving them in the lurch. As, however, the denunciation is contingent on the result of the deliberations at Brussels on the 8th of this month, and that decision will not be known till a day or two later, it may be as well to defer till another issue any examination into the effects that so reversionary a step is likely to have on the world's sugar industry. It must not be overlooked, however, that as Great Britain has already freed herself of all the restrictions binding on the participants in the Convention, her adhesion has of late been of so nominal a nature that the Powers may well decide to go on without her. Elsewhere will be found some expressions of Continental opinion on the subject.

M. Henri Pellet.

We have much pleasure in announcing that our well-known contributor, M. H. Pellet, has just received at the hands of his President the high recognition of being made a Knight of the Legion of Honour. M. Pellet is one of the most distinguished and respected chemists connected with the sugar industry, and has a record of original work that is truly remarkable. It is interesting to point out that he was born in 1848, and at the early age of 16 was lecture-assistant at the Rouen College of Sciences. He then entered the laboratory of Dr. Payen, and it was with this chemist that his first knowledge of sugar manufacture was gained. In 1872 he became associated with Champion, in collaboration with whom he published his first paper, and in 1873 was made chemist to the Fives-Lille Co. Later, he was in practice on his own account, but in 1887 received the appointment of chief chemist to the large central factory at

Wanze, Belgium. At the present time, he is chief chemist to a large group of beet factories and refineries in France, and of cane sucreries in Egypt, and is also in practice in Paris as consulting chemist. Thus he has actually had 47 years' experience in his profession, with 37 campaigns in the beet and 16 in the cane industry.

We have not space even to enumerate the immense amount of work that has been done by M. Pellet, and can only mention the most important of his researches. Some of our readers will remember the large amount of discussion that took place some twenty years ago relative to the question of the determination of sucrose in the beet by different methods; but that matter has been settled long since, and it is now generally recognised that the Pellet aqueous digestion method is the most simple, and sufficiently exact, in evidence of which it will be found in use in laboratories of factories and seed houses throughout the world. Perhaps the best known invention of Pellet is the continuous polariscope tube, by means of which it is claimed 15 polarizations can be made per minute. Indeed, we know of a large seed firm in Holland that is able with continuous observation tubes, and only two polariscopes, to make the remarkable number of 12,500 polarizations in 12 hours. Other practical time and labour saving apparatus devised by the subject of this note are: the capsule for the rapid determination of dry substance; the arrangement for estimating the marc in beetroot; the sulpho-carbonimeter; and the burette with double envelope. Then he has studied in detail a great number of points connected with cane and beet manufacture, such as: the determination of reducing sugars; the behaviour of sugar in the diffusion battery; the importance of using the real and not the apparent (Brix) dry substance in the sugar house; the nature of the reducing sugars of cane and beet products; the composition of the incrustations in evaporators; and particularly the important question of the undetermined losses of manufacture.

In brief, M. H. Pellet has published numerous and valuable researches dealing with every stage of cane and beet sugar manufacture, from the raw material to the last product. It is, however, especially in processes for the routine work of chemical control that the practical nature of the work of this eminent chemist is to be seen, and the time and labour saving methods devised by him for use in the several factories and refineries he controls would be a revelation to most chemists.

We offer our hearty congratulations to M. Pellet on the honour that he has just received, and express the hope that he may be able to add yet more to his remarkable record of service to the entire sugar industry.

Beet Sugar Growing in Victoria.

It is fairly well known that at Maffra in Victoria repeated attempts have been made to establish the beet sugar industry on a commercial

scale. We believe the first attempts proved a failure, and the schemes were abandoned for a time. Government assistance was, however, soon forthcoming, and further attempts were instituted with what appear to be now successful results. Some particulars in an official Victorian publication state that from 10 to 20 tons of beet per acre have been raised, while the farmers have been receiving £1 per ton for topped beets. The roots have been raised as far as 80 miles from the Maffra factory, being conveyed there on the State Railway at a maximum charge of 3s. per ton. Some of the farmers have made as much as £5 per acre; while 18 acres seems to have been the largest individual acreage. But it must not be overlooked that in Australia sugar fetches a higher price than the world's price, owing to the wall of protection with which it is surrounded.

Shredded Cane.

Considerable interest has been caused by the announcement made not many months ago (see *I.S.J.*, 1911, 160, 219) that a system had been devised for shredding and drying sugar cane and then transporting the dried shreds to a distant mill where the juice could be expressed. The particular experiment was carried out on cane grown in Cuba, and then shipped to a beet sugar factory in Madison, Wisconsin. We now learn that the trial has proved very promising, the purity of the juice extracted having been only slightly inferior to that of the original juice sampled at the time the cane was shred. The sugar crystallized well, but attempts to utilize the pulp for making paper were not very successful. It may, however, be pointed out that the shredders were too small to do much work, so that no concise data could be d wn therefrom; but as it was resolved to repeat the experiments this year with better and more powerful machinery more will be heard ere long of the process. It is apparent that this new idea has not yet got beyond the experimental stage, and that nothing definite as to the technical—not to mention the financial—aspects of the process is available. And it may be assumed that the cost of drying rapidly the shredded cane will be a formidable item in the total expense. It would, therefore, be as well for other interested parties to await a more detailed report ere seeking to embark on a similar experiment.

Mill Dimensions.

In our last "Notes and Comments" we mentioned the fact that in Java most of the mills have rollers, 60 in. × 30 in. It has, however, been pointed out to us that this size can no longer be considered the standard in that island, for though it still meets requirements in existing installations, especially when these work at a higher speed than they were originally intended to run, it is exceeded in the newer installations. For example, comparatively recent orders placed in

Glasgow for new machinery for Java have specified, 78 × 34 rolls and these are stated to have afforded such satisfaction that repeat orders have been given. At the same time the prevalent opinion, at any rate in Java, is that this latter size is the largest one practicable, inasmuch as, with bigger rolls, the crushing is no longer evenly distributed, some parts of the roller pressing harder than others. This view is also confirmed by the present Formosan practice, the most recent mills for that progressive island being fitted with rolls of identical dimensions (78 × 34), so that one may say that at present the preponderance of opinion is in favour of the 78 × 34 roll as the standard for large modern plants. True, this size has been exceeded; only two months ago we had to chronicle the construction of a 14-roller mill for South America which is being fitted with rolls of 84 × 40 ins., and is claimed to be the largest sugar cane mill ever made. How far this claim can be substantiated is probably a point for engineers to settle, but it is interesting to note that the size of the rolls, at all events, is no record, since as far back as 20 years ago a Scotch engineering firm made two mills for Cuba, the rollers of which were 84 × 48 ins. and which must have been running some 15 years ere they were renewed.

But if opinion is not unanimous about the best size for rollers, neither is it as regards the number of rollers in a train. There is, of course, a limit to the number that can be effectively used with a maceration system between, but that limit does not yet seem to have been authoritatively established; a few years ago 12 rollers were about the limit, now we hear of 14, 17, and even more being mounted, driven by one, two, or more engines. Doubtless in time these variations too will tend towards one standard, but it is early yet to hazard which combination will survive as the fittest.

The Brussels Conference.

As we go to press we are able to state that the Brussels Conference has had two sittings to consider the proposals of the Russian Government, but no result has yet been arrived at, the sittings being expected to last a week or more. *The Times* correspondent, however, reports that a good deal of discussion took place on the Russian question and several proposals were put forward tentatively in the course of the debate. One thing seems clear, and that is that there is a great desire for compromise; indeed, according to *The Times*, the Russian delegates have received instructions for entering into a compromise, while the British delegates have delivered no ultimatum but are reserving their decision. It is thought that once the Russian problem is solved, a programme for the renewal of the Convention in 1913 will be elaborated by the Permanent Committee to be submitted to the different Governments for approval. Even the German Government is said to be in favour of renewal.

RUSSIA AND THE SUGAR CONVENTION.

The consideration of the proposal that Russia should be permitted to export in excess of the quantity allowed under the terms of the Convention was adjourned till the 8th of December, in order to enable Russia to formulate proposals for renewing her membership of the Convention at its expiration in 1913. It was of course expected that Russia would make such proposals as might induce the other parties to the agreement to consent to her present request. Far from this being the case, it appears that Russia's proposals instead of being concessions to the other Powers are quite the reverse. Russia asks for greater powers of export under the new régime in 1913. How can this induce the other States to give her exceptional powers in 1911-12? The position would appear to be a deadlock. But before this appears we shall probably know what the Permanent Commission at Brussels has decided to recommend.

As at present advised it appears that Russia would like to have power to export 20 per cent. of her production every year—a production carried on under the stimulus of a very large Cartel bounty, estimated some years ago at 6s. to 7s. per cwt. on the total production. As an alternative she proposes a fixed contingent for the first year with an increase annually of 15 per cent. on the previous contingent. That is, 300,000 tons for the first year, 345,000 tons for the second, 396,750 tons for the third, and 456,262 tons for the fourth. Also an additional 100,000 tons whenever the world's price of sugar exceeds 15s. per cwt. Also that these figures should be cumulative, any short exports in one year to be added to the contingent for the next year.

It is difficult to imagine that the Parties to the Convention, not including Great Britain, who does not count, could be induced to allow a great bounty-giving country like Russia to remain a party to a Convention for the abolition of bounties under any such terms as these. They are demands not concessions.

No one can therefore be surprised to hear that the Syndicate of the sugar manufacturers of France have declared to their Finance Minister their desire that "the French delegates to the conference of 8th December reject the demand of Russia, and they see no other solution of the question in the future but the adhesion of Russia to the agreement of 1902, under conditions identical with those imposed on all the nations co-signatories of the agreement."

That is the only logical and practical conclusion, and it is very unfortunate that any other course was adopted in 1907. The *Deutsche Zuckerindustrie* is entirely of the same mind, and declares that the abolition of the "normirovka" should be the only admissible condition in according to Russia complete liberty of exportation.

Mr. F. Sachs, in the *Sucrerie Belge* of the 1st December, gives two alternative solutions of the question. First, if Russia considers that her sugar industry, in spite of the prosperity of recent years, is still too weak to compete on equal terms with the industries of the other countries when prices are at a normal level, she should be allowed to maintain her present ultra-protectionist legislation and be content to supply her home consumption and to export to Finland and Central Asia. Exportation to other countries should not take place except when the Russian crop has greatly exceeded expectations, or when the price of sugar in the world's markets is exceptionally high. The present annual contingent of 200,000 tons accorded to Russia appears fairly to correspond to these ideas. Perhaps it might be altered to 400,000 tons in two years.

Secondly, if Russia should be of opinion that she has, in recent years, made serious progress in the cultivation of the beetroot and the manufacture of sugar, and that it is to her interest to compete with the other countries by a *regular exportation* on the world's markets, she must act like the other Powers and suppress the favours which she at present accords to her industry, in conformity with the principles of the Brussels Convention.

Here again we have a logical and well reasoned statement, which ought to carry conviction to the minds of all assembled at Brussels,—except Great Britain, whose Government at the present moment does not desire the abolition of bounties. Such is the ridiculous position to which sham Free Trade has brought us. To the minds of the other Countries our position is incredible.

George Martineau.

THE INTERNATIONAL SUGAR SITUATION.

Some Current Opinions.

In a special article appearing in *The Times* on November 24th, that journal declared that opinions might differ as to the real benefits conferred by the Convention upon Great Britain, but only those who wilfully shut their eyes to facts can doubt that its working has been largely responsible for the revival during recent years of the cane sugar industry. The present unparalleled situation, brought on by the short beet crop and the Russian question, was one that needed a careful solution. To some minds the only logical step to take was to end or mend the Convention and that was apparently the attitude of our own Government in the matter. They had therefore threatened to denounce the Convention unless 500,000 tons of Russian sugar were allowed to come westwards during the current season. *The Times* then showed that in the opinion of the trade itself the drought of last summer alone was responsible for the present high prices.

Finally it considered that any withdrawal from the Convention on our part would lead to serious reprisals on our export trade in confectionery, and that therefore the best way out of the present *impasse* would be the reconstitution of the Convention on lines which made recognition of the changed conditions of the industry.

This article drew a letter from Mr. George Martineau, C.B., which we make no apology for reproducing *in extenso*, as it sums up very accurately the course of events that has produced the present situation, and offers a capable solution of the difficulty.

RUSSIA AND THE SUGAR CONVENTION.

TO THE EDITOR OF "THE TIMES."

Sir,—Your valuable article to-day gives a lucid exposition of the critical situation in which the Brussels Convention has been placed by the conduct of our Government. I wish, with your permission, to supplement it on one or two important points.

There have really been two Brussels Conventions, the original one of 1902 and the new emasculated one of 1907. The origin of the Convention of 1902 was the assurance given by the British Government that if the European Powers would enter into an agreement to abolish their bounties, Great Britain would undertake that they should no longer have to compete, on unequal terms, with bounty-fed sugar on British markets. Our efforts of 30 years to obtain a Convention were at once successful, and every European Power, with the only important exception of Russia, at once abolished its bounty. In 1907 the British Government repudiated the undertaking given in 1902, on the strength of which, and in full belief that it would be maintained, Germany, Austria-Hungary, France, Belgium, and Holland abolished their bounties. I must therefore respectfully demur to one passage in your article in which you say:—"It is clear that the undertaking given by the British Government in 1902, that those Governments joining the Convention should not again have to face the competition of bounty-fed sugar on British markets, has been broken by the privileges extended to Russia." The situation is far more serious than that. The present position of Great Britain in the Convention is now ridiculed by our Continental friends. They deplore the breach of faith, but they laugh at the idea of our having any further *raison d'être* in their deliberations. The *Sucrerie Belge* declares that "England no longer remains, since 1908, a party to the Convention except as a matter of form, since she admits the importation under equal conditions of all sugars, bounty or no bounty. The denunciation of the Convention by the English Government could not, therefore, produce any serious effect"; but it adds the following pregnant words:—"and would deprive England of a certain influence and, above all, of the advantage of continuing in good relations with the other Powers concerning the sugar question, and of being informed of everything connected with it."

That being the situation after 1907, the European sugar-producing countries found themselves face to face with Russia, where an enormous cartel bounty, organized by the Russian Government and strictly carried out, was stimulating production very rapidly, and where there was boundless

space of fertile land ready to respond to the stimulus. In 1908, Russia cultivated 556,000 hectares of sugar beet. In 1910 it had increased to 667,000 hectares, and in 1911 to 787,000. There would be no objection to such an expansion under natural conditions; on the contrary, we should be pleased to see Russian agriculture thriving. But for Germany and Austria to see their sugars—produced without any State aid—supplanted in foreign markets by a State-aided commodity would be intolerable, and no one could be surprised if the Governments of those countries were to declare that as they abolished their own bounties at the instigation of Great Britain and on the faith of a guarantee that they should not be undersold by bounty-fed sugar in British markets, which guarantee has been rudely withdrawn, they could now see no alternative but to resume the former war of bounties.

Why did Russia consent to join the Convention when she knew that she had an open door to her bounty-fed sugar in British markets? Evidently it must have been from fear that if she did not she would have to face this renewed war of bounties. Why did the other countries invite her to join? Evidently as the only means of enabling them to clip her wings.

If the British Government were not so blinded by the erroneous dogma of a sham Free Trade, they would see the situation clearly, and turn all their energies towards this grand opportunity for obtaining from Russia such modifications of her fiscal system as would procure the abolition of the present cartel bounty. If our Government would take up this position they would succeed in justifying their position in the Convention—at present only a matter *pour rire*—and would, if successful, become once more the leading State in that European concord.

It can be done; the other Powers would heartily and gratefully co-operate, and all sugar producers, British or foreign, would welcome the intervention of a Power which at present is, as far as sugar politics are concerned, very much under a cloud. As the *Journal des Fabricants de Sucre* of to-day says: "Abolition des primes d'un côté, maintien des primes d'un autre côté. Quelle étrange Convention!"

I am, Sir, yours faithfully,

GEORGE MARTINEAU.

Gomshall, Nov. 24th.

Among other letters appearing in *The Times* during November was one from C. Czarnikow confuting certain statements of Mr. Gibson Bowles. "The original Convention," he wrote, "was an attempt to prevent our Colonies from being openly ruined by Continental Trusts and to keep cane alive, in the absence of which, after this year's drought, Mr. Bowles would have had to pay 4d. per lb., Convention or no Convention." Another Mincing Lane broker wrote that the Brussels Convention was "the best solution of the question for England at the time, and has saved several of the cane crops from virtual extinction."

A strong indictment of the Government's policy appears in a recent issue of the *Sunday Times* by "Imperialist," much of which is well worth reproducing as it lays stress, in language which we think not a whit too strong, on the breach in diplomatic faith that our Govern-

ment have been guilty of for the sake of palliating one of the numerous sections of which its Parliamentary majority is composed.

"At the present moment (writes *Imperialist*) we are again exasperating Continental feeling in the most dangerous way and at a most dangerous time merely to satisfy the clamorous demands of a section of Government supporters. The cocoa and sweetmeat and marmalade manufacturers are enthusiastic Liberals—at a price, and that price is cheap sugar at all costs. To satisfy this clamour England has put the other signatories of the Brussels Convention into a very awkward position—has, in fact, betrayed them and given them just cause to say that the word of England cannot be trusted. It has been said that the wars of the eighteenth century were caused by sugar, just as the wars of the seventeenth century were caused by spice. There is some little truth in the remark—enough truth to enable me to say with confidence that the present bitterness against England in Europe is partly due to the "perfidy," as it is there called, with which we have treated the other parties to the Brussels Convention.

"The position may be put in a nut-shell. We induced the other signatories to abolish their bounty system on the understanding that we would not put them in a position of disadvantage in the British market as against countries which adhered to the bounty system. On that ground, and on that ground alone, Germany, Austria, France, Holland, and Belgium signed the Convention and abolished the system. But Russia adhered to its bounty and it became obvious to the signatories that all that stood between them and unfair competition in the British markets was England's pledge. This pledge (that is the penal clause) the Liberal Government denounced in 1908. It will be said that England had a perfect right to do it. That may be, but none the less the signatories looked upon it as practice of the sharpest kind within the law and as a piece of selfish and inconsiderate brutality. They had changed their policy owing to British solicitations and promises: they had some title to regard the arrangement as permanent, and now they found themselves abandoned. However, they softened the blow by admitting Russia to the Brussels Convention on an agreement which restricted her exports to 200,000 tons. Then came the bad harvest of the present year, which almost destroyed the European beet sugar crop, although it left the Russian crop uninjured. With rising prices the cocoa and sweet and marmalade makers renewed their howl. At any price we must have cheap sugar. So now Sir Edward Grey has threatened the other Powers that if they do not allow a large increase in the export of Russian sugar the Convention will be denounced at the earliest opportunity. The result is that the signatories are inflamed against our "perfidy" and there is, besides, a danger of the whole bounty system being restored.

"Now the Liberals will say: "Oh yes; that may be true, but would you have us starve the people, whose food is largely sugar?" The answer is that England had only to establish a countervailing duty on Russian bounty-fed sugar to the amount of the bounty and there would have been no embargo. That was all the signatories asked—a countervailing duty. But our Free Traders refused because a countervailing duty savours of Protection, whereas prohibition savours (one supposes) of Free Trade. There is no truth, then, in the assertion that the Brussels Convention must be denounced in

order to admit Russian sugar. All that is necessary is to impose a countervailing duty and that—because a miserable party point is feared—the Government refuses to do. To save a party score our neighbours on the Continent are bullied, tricked, outraged at a time when the goodwill of our neighbours was never more desirable. How can we have the sympathy of European nations, how can we obtain their confidence in our righteousness, if we resort to such shabby and doubtful courses in order that the cocoa Press may continue to support the Government and Mr. Winston Churchill sit safely on his marmalade pot?*

"And there is another aspect equally important. When the Brussels Convention was signed the sugar cane industry was on the point of extinction. But the abolition of the bounty system gave it new life. As a result, when the beetroot crop failed in Europe cane sugar was a most important factor in keeping the market from reaching famine prices. This fact has been stated even in the columns of the *Westminster Gazette*, and indeed could not be denied. The sugar planters had been given new life and new hope; they secured fresh capital and new machinery. Plantations which were about to be thrown out of cultivation were continued and new plantations laid down. Even in Mauritius the effect was felt. "There is no doubt," says M. Souchon, President of the Chamber of Commerce in that island, "the situation was saved by the abolition of bounties at Brussels," and he shows that whereas in 1900 the area under cane sugar amounted to 67,689 arpents, in 1908 it had risen to 92,082 arpents. What will the Colonists think of England if once more they are to be tricked and ruined, and to be laid a sacrifice on the altar of so-called Free Trade?"

This last paragraph it will be noticed gives the lie to those who assert that the Convention has done the Colonies no good. An opinion such as is expressed by M. Souchon counts for more than that of any number of armchair theorists at home.

In Czarnikow's Circular, dated November 23rd, the following appears:—

"Our Government stated on Tuesday that unless Russia was allowed to export 500,000 tons altogether this season Great Britain would withdraw from the Convention on 1st September, 1913. As we had virtually withdrawn from all restrictions some years ago, the declaration seems rather an empty threat. It may have a sentimental effect, though other countries might object to make concessions to people who only want to denounce a treaty which, anyhow, helped to save our colonies. It favoured the production of cane, which is our chief supply at present, and without which, when beet shows 1,700,000 tons deficiency, all the excess of Russia would have availed nothing."

The principal agitator in the press in favour of the denunciation of the Brussels Convention is undoubtedly Mr. George Mathieson, a leading London confectioner. He joined in the correspondence in *The Times* alluded to above, attempting to controvert the views expressed by the Special Correspondent of that Journal that the Convention had certainly not led to the present high prices. He also

* This refers to Mr. Churchill being one of the Members of Parliament for Dundee, a centre of marmalade manufacture.

took the opportunity to declare that British confectionery was already excluded from Convention countries, so that the threat of further penalties in that direction need create no fears. Mr. Mathieson's incursion into the arena, however, brought several crushing replies, two of them from experts who seldom intervene in these controversies. Mr. Edwin Tate declared that Mr. Mathieson had no right to claim to speak for the users of sugar as a body; and pointed out that the sugar refiners used double the quantity of sugar to that required by the confectionery trades, while they had just the same desire to get their raw material cheap. He said there could be no doubt that the rise in the price of sugar this year has been due to the failure of the 1911 beet sugar crop in Europe. He also affirmed that

"one important result of the operation of the Convention has been the salvation of the cane sugar producing industry. This beneficent influence has not been limited to the West Indies, but has encouraged the production of cane sugar in all parts of the world. The result is seen in the statistics for the present year. The estimated production of cane sugar, according to Messrs. Willett and Gray's statistics, being 8,789,000 tons, against a beet crop of 5,865,000 tons. In 1904-05 the total cane sugar crops were only 4,594,782 tons. These are significant figures, and it is almost unnecessary to ask what would have been the price of sugar at the present time had the trade been dependent for supplies upon the Continent, as but for the operation of the Convention I contend would probably have been the case."

Finally, Mr. Tate disposed effectively enough of Mr. Mathieson's assertion about the confectionery exports, by showing that a steady rise has taken place in this trade since the Convention was constituted. In 1900 the value of such exports was £606,867 and by a process of steady increase year by year reached the value in 1910 of £1,530,077.

"These figures" (concluded Mr. Tate,) "tell their own story, and it can hardly be doubted that if Great Britain withdrew from the Convention one of the first steps which would be taken by those countries who would continue the Convention would be to penalize the British confectionery industry, which, until the present time, has received preferential treatment."

Mr. R. P. Lyle wrote in much the same vein as to Mr. Mathieson's right to speak for the sugar users, and declared that the British refiners who accounted for 800,000 tons of raw sugar annually do not endorse Mr. Mathieson's views. He also (and here he was seconded by a letter from the Secretary of the West India Committee) pointed out that Mr. Mathieson's figures of the 1911 crop were erroneous, being no less than 683,000 tons too high according to the latest views of accredited statisticians. These figures were no doubt advanced to increase the plausibility of the claim that but for the Convention there would be no lack of sugar available. As it is, after this exposure, most persons will be inclined to agree with Mr. Lyle that Mr. Mathieson's letters can hardly be taken as a serious contribution to a difficult question.

SUGAR BEET AND ITS INDIRECT BENEFITS.

II.

In our former article on this subject we gave some interesting extracts from Mr. R. N. Dowling's account of his investigations in Germany. He describes visits to various farms and furnishes valuable figures of yield per acre, price of roots and cost of manufacture. These we reproduced correctly, but we inadvertently ascribed a summary of the results to Mr. Dowling. He now points out to us that this summing up was part of his quotation from the statement at the German farm. The farmer says:

"Thus we get yield, say 15 tons at 23s.	£17
Cost, including rent, rates, taxes, freightage, &c., say ..	12
Net cash profit per acre	£5

Our comment was that it would have been safer to have taken 13 tons and shown a profit of £3. We wish to explain now that this comment should apply to the statement of the farmer not of Mr. Dowling.

There is no doubt that Mr. Dowling, like ourselves, is most careful not to overstate his case, and most anxious to discourage all exaggerated statements, whether for or against the production of beetroot sugar. He has recently stated his views very clearly in the columns of the *Financial Times* and they furnish some useful additions to our former sketch of the indirect benefits of sugar beet culture. Mr. Dowling gives his opinion, founded on "experience of Continental and English soils, and on Continental results and results obtained in various colleges and centres in this country," that "one may safely predict a yield of from 13 to 16 tons per acre as a fair average crop on land that will now grow 25 tons of mangolds." This would leave the farmer ample margin for profit if he received rather more than £1 per ton delivered.

Mr. Dowling then proceeds: "There is, however, a much more important question than the one of direct profit to the farmer, and that is, 'Will sugar beet culture help to raise the standard of farming in England?' To my mind this seems to be the crux of the whole question to the tenant, the landlord, and the whole community in the neighbourhood of a factory. Such undoubtedly has been the result in the great sugar-beet areas in Germany, &c.; higher yields of other crops, more head of stock per acre, increased value of land, and the general prosperity of the whole countryside has followed in the wake of the sugar-beet." The writer proceeds to insist on the necessity for deep and thorough tillage and clean land. "Any one who knows the beet areas in Germany will testify to the wonderful state of cleanliness of all crops." Some farmers in England farm to perfection, but

this is the exception, not the rule. The sugar-beet farmer abroad knows that he will get at the end of the season a prompt cash return. The British farmer would be stimulated to adopt the same methods of high farming if he had the same prospect of a prompt cash return. Mr. Dowling adds: "Practice, with science, becomes an accomplished fact. The writer has seen the beneficial results throughout the length and breadth of the sugar-beet areas in Germany."

We can fully confirm his report. Mr. Dowling winds up: "In conclusion may I state that those who are trying to get to the bottom of this question can only deplore the many misleading statements that are made for and against the introduction of sugar-beet." We heartily re-echo this protest, which we have persistently urged.

SUGAR BEET NOTES: A MONTHLY CHRONIQUE.

By "Home Counties,"

Author of "Sugar Beet; Some Facts and Some Illusions: A Study in Rural Therapeutics."

Happily with every month that passes what is printed in this country on the question of sugar beet growing and beet sugar factories has a greater basis of knowledge. The advance within a year only in the general stock of information is noteworthy. From time to time, however, amazing over-statements and misconceptions are published. Every sincere student of the subject, everyone who wishes well by the countryside and by the sugar industry must feel that it is of the first importance that these over-statements and misconceptions should be corrected if those who have acreages to give to sugar beet, or money to invest in sugar beet factories, are not to walk in a vain show. In view of the prospect of the establishment of a pioneer industry in Cornwall, it is particularly to be regretted that so many exaggerations should have got into print in West of England journals.

"Proposed Factory at Hayle—Agriculture Revolutionized" are two headlines in a daily paper. Is it necessary to say that he who seriously counts on the revolutionizing of an agriculture so old and well-developed as our own can know little about agriculture?

Several papers have published photographs of sugar beets almost as monstrous in size as the prize mangels of the agricultural shows, though everybody who knows anything about sugar beets is aware that size is a most delusive characteristic. Passages in Mr. Stein's recent addresses and articles have clearly had their influence in leading the papers astray. Here are some quotations from Mr. Stein, which appears not only in the papers mentioned but in others:

For the past 100 years the Germans had grown sugar beet, but they could not produce more than 15 tons of sugar beet to the acre, whereas Cornwall

during the exceptional period of drought had grown 25, 28, 30, and 32 tons to the acre.—*Western Morning News*, Oct. 28.

At an exhibition at Hayle, over 2000 roots would be shown, grown by 140 Cornish farmers, some of them being four or five times the size of the German roots.—*Journal of Commerce*, Oct. 23.

The average German root was half a pound in weight, whereas at the lowest the average of the Cornish roots was 4 to 5. The average he placed at 22 tons per acre. The German root was a pigmy compared to the Cornish giant.—*Western Morning News*, Oct. 25.

It is true that in "a communication to the press" Mr. Stein slid down from the height of 32 tons:

"In a normal season, with more experience of growing sugar beet, and under the guidance of a factory agricultural inspector, (he said,) farmers in Cornwall should produce at least 22 to 24 tons per acre. In judging the average of the whole show of roots, I may say the average is 30 to 32 tons per acre. But of course this is an exhibition where the best roots are brought; therefore I do not say 32 tons, but only 22. But taking my calculation through, you will find that I under-estimate the average by putting it at only about 18 tons so as to be well within the mark. Thus you will see I am perfectly right."

Mr. Stein always is. But is it any wonder that the 18 tons reference should be forgotten or overlooked, and the taller figures alone make an impression? For instance, here is a daily paper in the West of England writing in its innocence:

Cornishmen will be gratified to learn how thoroughly they have beaten Germany with roots whose average weight is at least eight times as heavy as those of the Fatherland. If, as Mr. Stein is of opinion, Cornish farmers have demonstrated their abitity to produce a general average of 22 to 24 tons of beet per acre, the solution of the problem of raising our own sugar ought not to be regarded as—

and so on.

Mr. A. E. Showell, an associate of Mr. Stein in his campaign, sends a letter to the press in which he speaks of "20 tons to the acre" in Cornwall and says nothing to suggest that that is not a normal crop. Mr. Robson, another colleague, allows it to be assumed that "the weight per acre was over 25 tons." After this the following heroics come in quite naturally—the speaker is Mr. C. Hewetson Nelson, a third colleague:

If English people could grow beet, could they not manage a factory as well as the Germans? (A Voice: And beat 'em.)

It comes by nature, of course, running a sugar beet factory!

The Cornish factory scheme is described as based on contracts for 2500 acres of which 1900 have been secured, and the factory, to deal with 500 tons in 24 hours, is to be erected by a company with a capital of £100,000. Price for beets, 17s. at farm, 20s. delivered; against Mr. E. S. Ali Cohen's 20s. on rail or water and 21s. 6d. at the factory. Mr. Stein (*Western Morning News*, October 25th) says the farmers will make £5 net profit.

The harvesting of the Norfolk beets by the two dozen Hollanders has gone forward expeditiously and well. Mr. W. E. Sawyer states that he found six men lifting (per fork) and topping an acre a day. The beets were left in little heaps about three yards apart, and the tops all in a row, as one has seen in Holland. A local investigator's report is that ten men took up four acres in 2½ days, the crop being 9 to 9½ tons. Yet another enquirer says 10 men did from 2½ to 3 acres a day. The Beet Sugar Council's representative guesses the Norfolk crop at from 10 to 15 tons, or even more.

Mr. Sawyer bears testimony to the success of the Dutch mechanical horse-hoe in cleaning the beets earlier in the year without doing damage by trampling.

It is a pity that Mr. W. T. Chadwin, the Secretary of the Beet Sugar Council should yield to the temptation to write: "In both years we have grown sugar beet crops equal or superior to the best on the Continent at as little or *less cost*."* After saying what is the fact, that we can grow good crops of beets, what good purpose is to be served by suggesting that they may cost us less than they cost Continental farmers? Does anyone whose opinion is worth listening to believe it?

The Hollandia Company's Swedish pattern beet digger, or, rather, loosener, appears to have dealt with six acres of beet near Snape in 16 hours.

The Hollandia factory people are understood to have completed the purchase of the land at Maldon where the East Anglia Company, the capital of which is still, I believe, nominal, hoped to have built, so they evidently think that the site will be wanted one day.

I was visited the other day in Essex by an Inspector of the Irish Board of Agriculture who was studying the sugar beet question with a view to possibilities in Ireland.

The following paragraph (from a review of my book in *The Times*) gives such a weighed and informed opinion on the sugar beet question that it is well worth reproducing:

It is certain that the beet crop offers no golden prospect to the farmer. On paper mangels, which yield quite twice as heavily, are the more lucrative crop, and they are suited by much the same conditions. But it is equally certain that beet growing is a good national investment. It means always and everywhere high farming and the extinction of weeds. It produces minor industries, and gives prosperity to a neighbourhood. The refuse is all valuable food for stock and is becoming, under the latest drying methods, very portable. The farmer can make a good if not startling profit, and his grain crop in the following year will astonish him. It is perhaps not too much to say—so rich is the succeeding crop—that the profits of beet growing depend almost as much on the price of grain as of sugar. The protection of corn is indeed a sort of sugar bounty, and this fact destroys many of the analogical arguments from the Continent to England. Holland,

* Italics are mine.

however, is conspicuous for its beet factories,* and Holland is but the other end of the valley which declines into the sea on our eastern coast. It will be a good omen for the intensive farming in England when the first factory is built and the south-western slope of that sunny valley copies in this respect the north-eastern.

Newly returned from Holland as I am, I have a vivid impression of the part which sugar beet plays in the successful agriculture of that country. It was strongly urged upon me by the agricultural instructors that sugar beet could do wonders for us over here. The point about which we have been in doubt, however, is as to the exact opening which exists in a country the agriculture of which is so highly developed as our own. The writer of the *Times* article naturally knows more about the condition of our farming than the *Rikslandbouwleeraren* of the Netherlands, and if he thinks that there is the opening here, some importance must be attached to his belief.

THE RELATIVE EFFICIENCY OF A SIX-ROLLER MILL COMPARED WITH A NINE AND TWELVE-ROLLER MILL WITH CRUSHER.†

By S. G. CHIQUELIN,

Director of the Audubon Park Experiment Station, New Orleans.

The topic for discussion before this Association to-night should be of deep interest to planters who contemplate increasing the capacity of their factories in the near future, and wish to learn of the relative and approximate extraction that may be obtained from 6, 9 and 12-roller mills.

By looking over the Planters' Year Book, it was found that the total sugar produced last year was, in round numbers, 342,000 tons, and the yield per ton, 138 pounds. There were 207 factories in operation, with an average output of 3,319,319 pounds per factory. Of this number, 9 were of the 3-roller type; 7 of the 5-roller; 154 of the 6-roller, and 10 of the 9-roller; 27 not being mentioned as to type of mill. Of the 9-roller, 4 are without crushers, hence it may be seen by these figures very little of the cane was crushed by the 9-roller and crusher type. From the figures available, though not as general of the sugar belt as I had hoped to get, we had for the past season an average sucrose in juice of 11·10 per cent., against a general average for the past ten years of 11·60 per cent., so it can be reckoned that

* The writer's allusion is to the fact that Holland has no import duty on grain.—H.C.

† A Paper read before the Louisiana Sugar Planters' Association, October 12th, 1911, and reprinted from *La. Planter*.

in the past season, while the cane was not up to normal, it may be considered good, or very nearly up to the 10 years' average. Cane of such a composition should yield, with 76 per cent. extraction, in the neighbourhood of 154 pounds of commercial sugar per ton of cane, against 138 pounds as reported in the Planters' Year Book. While it is a fact that some few planters sold their first and second molasses to dealers instead of converting the same into sugar, yet it was found, on investigation, that only a few had done so, very nearly all of them having been worked back to third sugars. If the above figures are correct, and we are to assume a 28° purity of molasses being the limit of exhaustion of our blackstrap, we are led to believe that our average extraction for the State was nearer 73 per cent. than 76 per cent., as is generally supposed.

Two years ago the Louisiana Sugar Company, realising what wide differences existed in results obtained from their various factories, instituted a uniform chemical control for the purpose of "checking-up" each factory, in comparison with another, so as to find out where any discrepancies might arise. In so doing, much valuable information was obtained.

From the Company, and through the courtesy of their supervising chemist, Mr. Morse, I have the following comparison between a 6 and 9-roller mill. The figures thus given are from actual work done from two of the six factories under control, one a 9-roller and crusher 6 ft. mill, and another a 6-roller and crusher 7 ft. mill.

Gain in capacity and extraction of a 9-roller over a 6-roller mill:—

	6 ft. Mill (9-roller.)	7 ft. Mill (6-roller.)
Tons of cane ground per hour	43·2	39·61
Length of roller in ft.	6	7
Tons ground per hour per ft.	7·72	6·50
Per cent. gain in capacity	—	18·77
Juice extraction	79·15	77·45
Per cent. maceration	18·26	12·80
Sucrose lost in bagasse, lbs.	21·80	26·64
Per cent. sucrose lost, lbs.	4·27	5 02
Fibre in cane	10·82	10·32

The results above obtained furnish during the past season an excellent means of comparing the relative value of 6 and 9-roller milling.

	6-roller.	9-roller.
Tons of cane ground per hour	43·2	39·61
Square ft. of roller surface per hour, front mill only	9360	7313
Tons of cane per sq. ft. roll	0·00461	0·00541

From this comparison the 9-roller mill grinds 17·35 per cent. more cane per sq. ft. of rolling surface than the 6-roller mill, due entirely to the third mill, and still retains a slight advantage in mill extraction. With an additional mill to the 6-roller type, this mill could grind 50·6 tons per hour, or 1214 tons per day, and at the same

time secure the same extraction. Without the third mill, the 9-roller 6 ft. mill would grind 33·75 tons per hour, or 810 tons per day. The increase, then, from a 7 ft., 6-roller mill to a 7 ft. 9-roller mill in this case was 264 tons per day. If, then, by converting a 6 ft. 7-roller mill into a 9 we increase its capacity 264 tons per 24 hours, might it not be safe to assume that the same mill converted into a 12-roller mill will increase its capacity in a like proportion—in other words, to 1478 tons per day, and still retain the same efficiency?

In Hawaii, the comparison of a 9 and 12-roller mills with the same length of rolls was made, in which it was found, by actual trial, that a 12-roller mill would treat 50 tons of cane per hour as efficiently as a 9-roller set treats 35 tons, with a dilution of 12 per cent. compared with one of 34 per cent.; and in Porto Rico it was found, also by actual test, that a 15-roller set increased the extraction 2 per cent. on weight of juice in cane over a 12-roller mill.

The great advantage of 9 and 12-roller mills is the possibility of saturating behind the rollers, due to the disintegrated condition in which the bagasse emerges after repeated crushings. Whereas, with 6-roller mills the same conditions do not exist, and the efficiency of maceration is considerably reduced, even though as much water had been added to it as to a 9 or 12-roller mill.

We might here mention the results that were obtained by Mr. Hedemann during a whole season in the Hawaiian Islands, by means of a 12-roller mill:—

Sucrose in cane	15·37
Fibre in cane	10·98
Sucrose in bagasse	3·28
Moisture in bagasse	45·66
Fibre in bagasse	49·92
Sucrose lost in bagasse on cane	0·76
Dilution	26·12
Extraction on 100 sucrose on cane	95·40

While the term "extraction," as used in Hawaii, means the sucrose extracted on 100 in juice, by the interpretation of these results in our mode of expressing extraction, we have 84 per cent. as juice on weight of cane. Cane from tropical countries, containing anywhere from 10 to 20 more woody fibre than ours, makes it that much more difficult for a mill to reach that efficiency that a similar mill could obtain in this country. We have figures to show that a 7 ft., 6-roller mill, with crusher, grinding at the rate of 43 tons per hour, with extraction of 77·6, by simply adding another mill, thereby making it a 9, and with 13·1 per cent. maceration, increases the extraction to 82·6 per cent., and sucrose in bagasse of 2·66 per cent. While these figures hold good only on the assumption that the water of maceration is thoroughly mixed with the bagasse, which we know is not the case, yet they come well within the limits of actual work performed. We

have also the analysis of bagasse to indicate good from bad milling, and in many instances I have seen analyses showing from 5 to 6·5 per cent. sucrose left in bagasse, indicating bad mill work. We have also reports on mill extraction from a 12-roller mill in Porto Rico train giving 84 to 85 per cent. extraction. It may, therefore, be safe to assume that with our cane, containing, as it does, much less woody fibre than cane from the tropics, an 85 per cent. extraction could hardly be considered high for Louisiana by the use of a train of 12 rollers and crusher, using, say, 25 per cent. maceration.

From these results thus given, and the actual work done in tropical countries, we might, without much hesitation, summarize the efficiency of 7 ft., 6, 9, and 12-roller mills as follows:—

	6-roller, with crusher.	9-roller, with crusher.	12-roller, with crusher.
Rate of grinding per 24 hours in tons	1100	1100	1100
Maceration	15·20	20·25	20·25
Extraction	76·78	82·83	84·86

Or, basing on calculated work done by means of 6 and 9-roller mills as given from table for same size mill and extraction, we have:—

	Tons.
7 ft. 6-roller mill and crusher grinding per 24 hours	950
7 ft. 9-roller ,, ,, ,, ,, 24 ,,	1214
7 ft. 12-roller ,, ,, ,, ,, 24 ,,	1478

In addition, a table is here given to show the effect of mill extraction on the yield of commercial sugars per ton of cane:—

Per cent. Extraction.	Per cent. sucrose in normal juice 10 lbs.	12 lbs.	14 lbs.
72	3·6	4·4	5·4
74	7·2	9·0	10·6
76	10·7	13·4	16·0
78	14·4	17·8	21·3
80	18·0	22·3	26·7
82	21·5	26·8	32·0
84	24·9	31·6	37·2

From this table it is seen how important the question of extraction is to the Louisiana planter, when one takes into consideration the cost of a pound of sucrose in cane delivered on the carrier as compared with tropical countries.

Some experiments have recently been carried out in Lanai, Hawaiian Islands, with a view to growing sugar beets. They have, however, not proved successful, and all further attempts have been abandoned. The failure does not appear to have been due to want of trying. An expert from California was obtained to superintend the field operations, and an irrigation system was available. But the roots appear to have suffered at an early stage from the ravages of the cutworm and the average sugar yield obtained was too low to encourage further trials. So the land was turned over for grazing.

ON THE USE OF MOIST BAGASSE IN CANE SUGAR FACTORIES, ETC.

By L. MURGEON.

Wood fuel containing more or less moisture is frequently used in cane sugar factories, tinctorial extract factories, tanneries, distilleries, oil works, etc.

Notwithstanding its moisture, such fuel may be burnt, as it is, under boilers provided with suitable grates. But in any case it would be of very great advantage to partially dry the fuel before use, on condition, of course, that this desiccation is not too costly.

In order to see if such desiccation is realizable in practice, we shall first calculate the economy obtainable.

Curve of equivalent dry substance.—In the accompanying curve, which we term "the curve of equivalent dry substance", are given along the ordinates the different weights of bagasse, and along the abscissae are the percentages of water which contain the same weight of dry substance as 4·17 kilogrms. of bagasse with 50 per cent. of water.

The equation of this curve is:—

$$y = 4{\cdot}17 \times \frac{50}{100} \times \frac{100 - x}{100} = 4{\cdot}17 \times \frac{100 - 50}{100 - x}$$

Curve of equivalent calorific power.—The second curve, which we call "the curve of equivalent calorific power," gives the weight of bagasse with different water contents corresponding to the same calorific value as that possessed by 4·17 kilogrms. of bagasse containing 50 per cent. of water.

Its equation is established as follows: 1 kilogrm. of dry substance of the bagasse containing 50 per cent. of water of composition and 50 per cent. of carbon, has a calorific power equal to half that of 1 kilogrm. of carbon; that is to say to $\frac{8{\cdot}100}{2} = 4{\cdot}050$. So as to transform 1 kilogrm. of water at 0° C. into steam at 0° C. 606·5 calories are required. When moist fuel is burnt, the hygroscopic water contained in it is vaporized, absorbing then 606·5 calories per kilogrm, in the form of latent heat, *i.e.*, heat that is not perceptible in the products of combustion contained. The weight y^1 of bagasse with x per cent. of water calorifically equivalent to 4·17 kilogrms. of bagasse containing 50 per cent. of water must then contain a weight of dry substance higher or lower than 2·085 (the dry substance contained in 4·17 kilogrms. of bagasse containing 50 per cent. of water) by an amount representing exactly the latent calories necessary for the vaporization of the difference between 2·085 and the weight of water contained in the y^1 kilogrms. This reasoning is interpreted by the following equation:

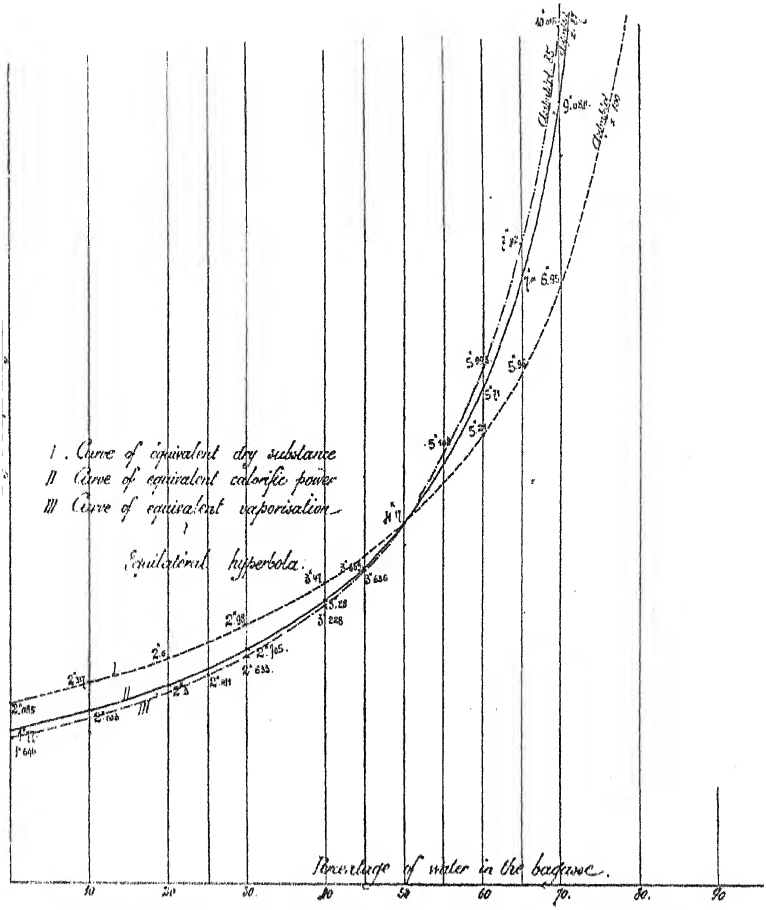
$$\left(y^1 \times \frac{100 - x}{100} - 2{\cdot}085\right) \times 4050 = \left(\frac{y^1 x}{100} - 2{\cdot}085\right) 606{\cdot}5\,;$$

which may also be written:

$$y^1 = 4{\cdot}17 \; \frac{405{,}000 - 4656{\cdot}5 \times 50}{405{,}000 - 4656{\cdot}5\, x};$$

and this is the equation of the curve of equivalent calorific power.

Curve of equivalent vaporization. Besides the increase of the calorific power of the fuel, drying causes an increase in the temperature of the



combustion gases, and, *ipso facto*, an increase in the rendement of vaporization of the fuel.

In order to determine the useful effect of the evaporation of the fuel with its different contents in water, the equation of a third curve called "the curve of equivalent evaporation" is stated.

The combustion temperature of 1 kilogrm. of bagasse containing

per cent. of water with a consumption of 15 kilogrms. of air is for 1 kilogrm. of dry substance:

$$T = \frac{4050\left(\frac{100-x}{100}\right) - 605{\cdot}5\,\frac{x}{100}}{\left(\frac{100-x}{100}\,15+1\right)0{\cdot}25}.$$

On the other hand it is known that if the temperature of the water in the boiler is about 150° C. the temperature of the gas leaving the generator will be:

$$T^1 = 150 + (T-150)\,e^n\,;$$

in which formula, n is a constant depending neither on the temperature T, nor on the moisture of the fuel.

The rendement in vaporization of the fuel will therefore be:

$$R = \frac{T-150}{T}\,(1-e^n) = K\left(\frac{T-150}{T}\right);$$

which last expression, by replacing T by its value calculated above, becomes:

$$R = K\,\frac{345{,}000 - 4094\,x}{405{,}000 - 4656{\cdot}5\,x}.$$

The weight y^2 of fuel containing different moisture contents necessary for producing a similar vaporization in the boiler will be equal to the weight y^1 multiplied by an inverse factor of the rendement of vaporization R. Hence there will be:

$$y^2 = y^1\,\frac{1}{R} = \frac{1}{K} \times \frac{405{,}000 - 4656{\cdot}5\,x}{345{,}000 - 4094\,x} \times y^1 = \frac{1}{K} \times 4{\cdot}17 \times \frac{405{,}000 \times 4656{\cdot}5 \times 50}{345{,}000 - 4094\,x}\,;$$

the value of K is readily calculated, and knowing that $x = 50$, and $y^2 = 4{\cdot}17$, we have:

$$K = \frac{405{,}000 - 4656{\cdot}5 \times 50}{345{,}000 - 4094 \times 50}.$$

Replacing K by this value in the equation y^2, it will be:

$$y^2 = 4{\cdot}17\,\frac{345{,}000 - 4094 \times 50}{345{,}000 - 4094\,x}.$$

This is the desired equation of the third curve or uniform vaporization.

The figures of the curve of equivalent vaporization are found to coincide very closely with the results of direct vaporization experiments made by M. Fribourg, chemical engineer in the factories of the Société des Sucreries Bresilliennes (Maurice Allain). These experiments showed that the weight of equivalent vaporization with bagasse containing 50, 45, and 40 per cent. of water, was 4·17, 3·59, and 3·23 respectively. Now the curve made by us, taking the same weight of 4·17 kilogrms. with 50 per cent. of water, gives for 45 and 40 per cent. of water 3·636 and 3·228 respectively.

It follows from these curves that the difference of the ordinates for the different contents of water lower than 30 per cent. are appreciably the same. Hence there is no advantage to push the drying lower than 30 per cent. of water.

Finally, we wish to point out that the weights of fuel ordinates in the second curve correspond to the same calorific value as 1·77 kilo-

grms. of completely dried wood, *i.e.*, to 1 kilogrm of coal with $1·774 \times 4050 = 7{,}200$ calories.

Practical Conclusion.—By way of example we shall take bagasse, although the argument applies equally well to other forms of wood. The bagasse from 400—450 tons of cane treated in 24 hours represents about 90 tons with 50 per cent. of water. In burning this, according to the third curve, the same vaporization as in burning $\frac{90 \times 2633}{4·17}$ tons of bagasse containing 30 per cent. of water will be obtained. On the contrary, in drying the 90 tons of bagasse there follows from our curves $90 \times \frac{100-50}{100-30}$ tons of bagasse containing 30 per cent. of water.

Hence the economy effected by drying will be represented by the value of :—

$90\left(\frac{50}{70} - \frac{2·633}{4·17}\right) = 7·45$ tons of bagasse containing 30 per cent. of water.

Now this quantity is practically equivalent (see the curve of equivalent vaporization) to :

$7450 \times \frac{2·411}{2·633} = 6825$ kilogrms. of wood, with 25 per cent. of water (*i.e.*, air-dried).

Taking wood at 15 francs per ton at the factory, which is a minimum, the economy realized by drying is therefore $6{,}825 \times 15 = 102·40$. *In 15 days this economy then amounts to 15,360 francs.* In order that this economy should all be obtained, it is necessary that the desiccation should be free of expense, that is to say, that it should be carried on by utilizing the lost heat in a plant that does not require any labour, and in a factory where the small motive power necessary for operating the drying apparatus can be obtained by using the waste steam.

These conditions are particularly well fulfilled in the patent system of Alph. Huillard, of Suresnes, near Paris, which has been employed for a number of years in the different industries enumerated at the commencement of this article. The saving in cost that we have just figured enables cane sugar factories to recuperate the cost of installation in three campaigns of 150 days, and in only 18 months in industries working all the year.

In conclusion, so as to enable those interested to take account of the economy realizable in each case particularly concerning them by drying the fuel to 40 per cent. of water before its use, we give the following formula deducted from the preceding reasoning.

Daily economy in francs:

$$P\left(\frac{100-n}{100-30} - \frac{345{,}000 - 4094 \times n}{345{,}000 - 4094 \times 30}\right)\frac{7200}{2·705} \times \frac{1}{C} \times \frac{9}{1000}$$

in which $P =$ the weight of moist wood, in kilogrms., dried per day ; $n =$ the percentage of moisture in this wood ; $c =$ the calorific value of the extra fuel (wood or coal) employed in the factory ; and $q =$ the price in francs per ton of this extra fuel.

THE ANDRLIK UREA METHOD OF POLARIZATION FOR CANE PRODUCTS.

By WILLIAM E. CROSS, Ph.D., and W. G. TAGGART, B.Sc.
(Sugar Experiment Station, Audubon Park, New Orleans, La.)

In the ordinary Clerget determination of true sucrose in molasses and other low sugar products, there is one source of error which has so far not been circumvented: the fact that the single polarization is taken in neutral, and the invert polarization in acid solution.

The error is caused by the effect of the acid on substances other than the sucrose originally present in the molasses; and as in cane products large proportions of invert sugar are present, besides the ordinary non-sugars, this error is probably greater here than with beet products. For beet molasses Andrlik * has recommended taking the single polarization in acid solution of the same concentration as in the invert reading, the inversion of the sucrose at ordinary temperature being prevented for a few minutes by the addition of urea or betaine. Pellet † recommends this method also for cane products, and we have therefore been led to investigate the method from the cane standpoint.

In the first experiments the retarding action of betaine was studied. In one case 50 c.c. of a normal sucrose solution was taken, 5 c.c. hydrochloric acid (sp. gr. 1·18) added, and the mixture diluted to 100 c.c., and the fall in polarization on standing (at 28° C.) measured. In the second case, 50 c.c. of normal sucrose solution, 10 c.c. of a solution containing 5 c.c. hydrochloric acid (sp. gr. 1·18) + 5 grms. betaine, was made up to 100 and polarized. The results were as follows:—

TABLE I.

Time.	A. Sucrose + 5 per cent. hydrochloric acid. Polarization. I. (28°C.)	A. II. (28°C.)	B. Sucrose + 5 per cent. hydrochloric acid + 5 per cent. betaine. Polarization. I. (28°C.)	B. II. (28°C.)
After 1·5 min.	24·5	24·5	—	—
,, 2 ,,	—	—	24·4	24·5
,, 3 ,,	24·1	24·2	24·0	24·3
,, 4 ,,	23·7	24·0	23·6	24·0
,, 5 ,,	23·4	23·7	23·2	23·6
,, 6 ,,	22·95	23·5	22·8	23·3
,, 7 ,,	22·5	23·0	22·5	23·0
,, 8 ,,	22·0	22·8	22·1	22·7
,, 9 ,,	21·8	22·6	21·7	22·3
,, 10 ,,	21·4	22·3	21·4	21·9

* *Zeitsch. Zuckerind. Böhm.*, *31*, 417.
† *I.S.J.*, *13*, 206.

Time.	A. Sucrose + 5 per cent. hydrochloric acid. Polarization.		B. Sucrose + 5 per cent. hydrochloric acid + 5 per cent. betaine. Polarization.	
	I. (28°C.)	II. (26°C.)	I. (28°C.)	II. (28°C.)
After 11 min.	21·0	21·8	21·1	21·7
,, 12 ,,	20·7	21·5	20·8	21·3
,, 13 ,,	20·4	21·3	20·5	21·0
,, 14 ,,	20·1	21·0	20·2	20·8
,, 15 ,,	19·8	20·7	20·0	20·4
,, 20 ,,	18·5	19·5	18·5	19·0
,, 25 ,,	17·0	18·5	17·2	17·4

The values in experiments A (I.) and B (I.) were plotted, and gave the curves shown in Fig. I.

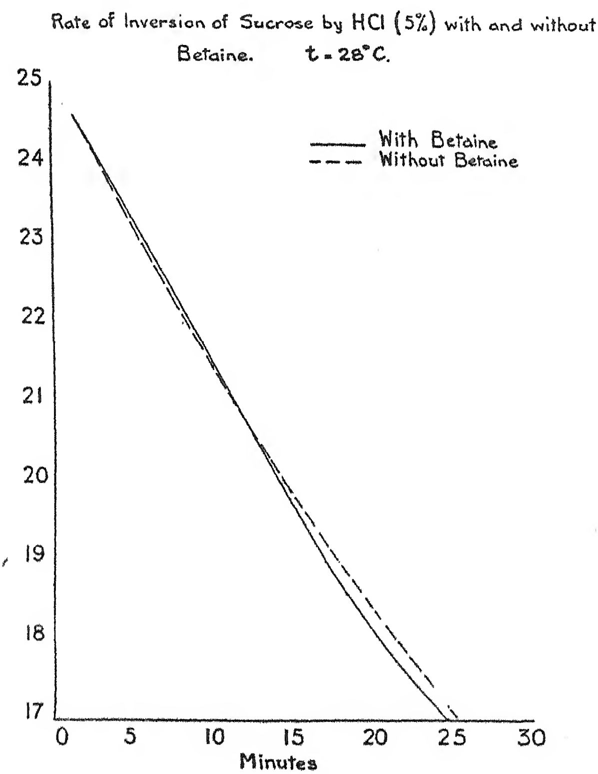


Fig. I.

From these values it is apparent that at the temperature used (28° C.) the betaine was almost without retarding action on the inversion of the sucrose. Similar experiments were carried out with urea. The solution containing urea contained 50 c.c. of normal sucrose solution, + 10 c.c. of a solution containing (in 10 c.c.) 5 c.c. of hydrochloric acid (sp. gr. 1·18) + 5 grms. urea, in 100 c.c. The other solution contained 50 c.c. normal sucrose solution + 5 c.c. hydrochloric acid (sp. gr. 1·18) in 100 c.c. (*i.e.*, without the urea). The fall in polarization of these solutions was also followed out at 28° C.

TABLE II.

Time.	A. Sucrose + 5 per cent. hydrochloric acid. Polarization.		B. Sucrose + 5 per cent. hydrochloric acid + 5 per cent. Urea. Polarization.	
	I. (28° C.)	II. (26° C.)	I. (28° C.)	II. (28° C.)
After 1·5 min.	24·5	24·5	—	25·0
,, 2 ,,	—	—	—	24·9
,, 2·5 ,,	—	—	24·9	—
,, 3 ,,	24·1	24·2	—	—
,, 4 ,,	23·7	24·0	24·7	24·6
,, 5 ,,	23·4	23·7	—	24·4
,, 5·5 ,,	—	—	24·5	—
,, 6 ,,	22·95	23·5	—	24·2
,, 6·5 ,,	—	—	24·3	—
,, 7 ,,	22·5	23·0	24·2	24·0
,, 8 ,,	22·0	22·8	24·1	—
,, 8·5 ,,	—	—	—	23·8
,, 9 ,,	21·8	22·6	24·0	—
,, 10 ,,	21·4	22·3	—	—
,, 10·5 ,,	—	—	—	23·45
,, 11 ,,	21·0	21·8	23·75	—
,, 11·5 ,,	—	—	—	23·3
,, 12 ,,	20·7	21·5	23·5	..
,, 13 ,,	20·4	21·3	—	23·1
,, 14 ,,	20·1	21·0	23·3	23·0
,, 15 ,,	19·8	20·7	23·2	22·85
,, 20 ,,	18·5	19·5	22·3	22·1
,, 25 ,,	17·0	18·5	21·8	21·4

The value in experiments A (I.) and B (I.) were plotted and gave curves as in Fig. II.

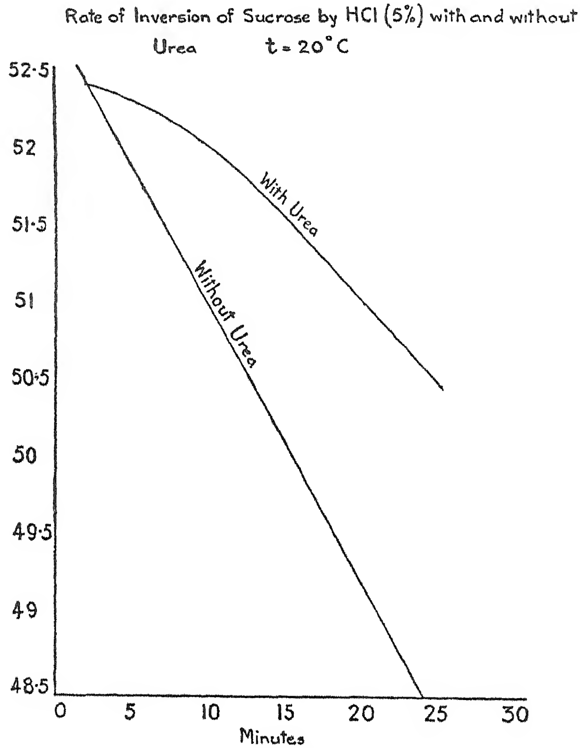


Fig. II.

It is seen that urea retards the inversion to some extent, but that this retardation is insufficient to allow of the single polarization being obtained before the inversion sets in. Some experiments on this point gave results as in Table III.

Table III.

(t = 28° C.)

Solution.	True Single Polarization.	By Urea Method. Single Polarization.	By Urea Method. Time. Min.	Clerget.	Urea Clerget.
Sucrose I.	25·00	24·7	4	—	—
,, II.	25·00	24·6	4	—	—
Sucrose and invert sugar, I.	38·3	38·0	2	39·84	39·6
,, ,, II.	38·3	37·95	1·5		
,, ,, III.	38·45	38·0	3·5	—	—
,, ,, IV.	38·3	38·01	1·5	—	—

The Clerget values given showed the lower Clerget results obtained by the urea method, due to the single polarization by the urea method being too low.

Rate of Inversion of Sucrose by HCl (5%) with and without Urea. t = 28° C.

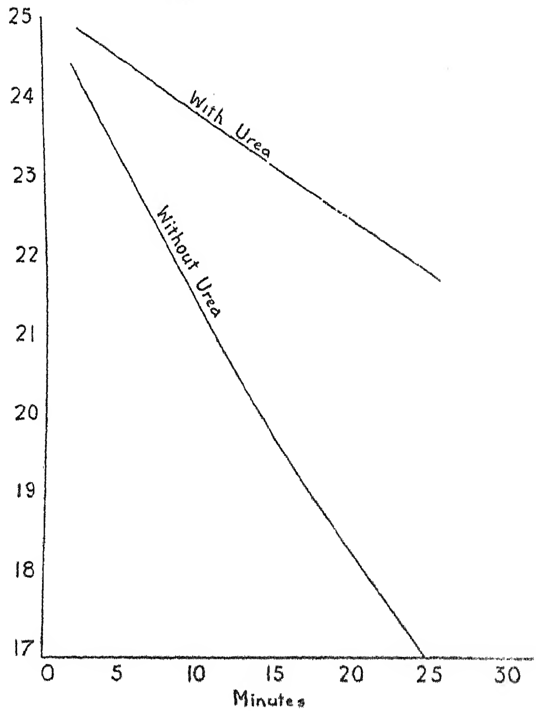


FIG. III.

All these experiments were carried out at 28°C. (82·4 F.) because any method for the analysis of cane molasses must be practicable at this temperature, the ordinary temperature of working in cane producing countries. To see how far the method might be applicable at lower temperatures, however, a series of observations were made on the rate of inversion with and without urea, at 20° (68°F.). The results are shown in Table IV., and on the curve of Fig. III.

TABLE IV.

(t = 20° C.)

Time.	A. Sucrose + 5 per cent. hydrochloric acid. Polarization. I.	II.	III.	B. Sucrose + 5 per cent. hydrochloric acid + 5 per cent. Urea. Polarization. I.	II
After 2 min.	—	52·9	52·5	52·5	52·5
,, 2·5 ,,	52·5	—	—	—	—
,, 3 ,,	52·0	—	52·2	—	52·4
,, 3·5 ,,	—	52·6	—	—	—
,, 4 ,,	51·5	—	—	—	—
,, 5 ,,	51·6	52·4	52·0	52·4	52·35
,, 6·5 ,,	51·3	—	—	—	—
,, 7 ,,	—	51·9	51·6	52·35	52·3
,, 7·5 ,,	51·0	—	—	—	—
,, 8 ,,	—	51·8	51·4	—	—
,, 9 ,,	50·7	—	—	—	52·05
,, 10 ,,	—	51·6	51·0	52·1	52·0
,, 11 ,,	50·05	—	50·95	—	51·95
,, 11·5 ,,	—	—	—	51·85	—
,, 12 ,,	50·2	—	—	—	51·9
,, 13 ,,	50·1	51·1	50·5	—	—
,, 14 ,,	—	—	50·3	—	51·7
,, 15 ,,	49·7	50·5	50·1	51·4	51·65
,, 20 ,,	49·4	50·1	49·1	50·6	51·0
,, 25 ,,	48·7	49·1	48·2	49·9	50·5

Plotted values of experiments A (III.) and B given in Fig. III.

Thus it is apparent that even at the comparatively low temperature of 20°C., the inversion sets in before sufficient time has elapsed to allow of the single polarization being measured.

Results of analyses at 20°C. of sugar solutions by the ordinary and the urea method are given in Table V. It is seen that the single polarization by the urea method is always too low, due to partial inversion of the sucrose; and that the Clerget results are also too low in consequence. The importance of the time element is also seen from Table V.; if the single polarization of the first solution were taken after four minutes, it would be 99·11, if in seven minutes, 98·78, and the Clerget result is modified accordingly.

TABLE V.

($t = 20°$ C.)

Solution.	True pol.	Urea Method.	Time. Min.	Clerget.	Urea Clerget.
Pure sucrose	99·9	99·11	4	100·00	99·41
	—	98·78	7	—	—
	—	98·34	9	—	—
	—	98·01	10	—	—
Sucrose 96 per cent. and invert sugar 4 per cent.	(*a*) 93·9	93·61	4	95·97	95·75
	—	93·28	7	—	—
	—	92·90	9	—	—
	—	92·73	10	—	—
	(*b*) 93·9	93·50	4	—	—
	—	93·17	7	—	—
	—	92·62	9	—	—
	—	92·40	10	—	—

It is possible that at some lower temperature, say 15°C., the method might be a practicable one, but at 20°C. and especially at 28°C.—the temperature of working in cane countries—it would appear to be entirely impracticable.

CONSULAR REPORTS.

PHILIPPINE ISLANDS.

The British Vice-Consul at Manila in his report for 1910 states :—

119,511 tons of sugar were exported to the value of £1,505,080. This shows an increase in value but decrease in quantity. The explanation of the satisfactory state of this industry is found in the high prices prevailing and the increased exportation to the free market of the United States. The amount sent there fell short of 100,000 tons, or not quite a third of the free trade limit. In view of the increased activity on sugar estates in 1911 and the large profits to be obtained, further development of this industry is assured.

I am indebted to a resident British merchant for the following :—

The United States markets took the high grade sugars, only such low sugars as were unsaleable in the United States going to the China markets.

The falling-off in the production was undoubtedly due in part to the steady decline of the industry on account of previous low prices, but more particularly to the cattle disease which practically wiped out the available animals for ploughing, &c., purposes. Planting to meet the better demand owing to sugars being admitted into the United States free of import duty, and the successful means taken to eliminate cattle disease, have not yet had their effect on shipments.

There is little doubt but that the removal of the duty has now had the effect of staving off the steady decline of the Philippine sugar industry. Low prices and antiquated methods of planting and milling had made planting become almost unremunerative.

Now the industry has apparently a bright future before it. American capital has entered the field, and a large estate in Mindoro is being cultivated on modern methods and modern machinery installed. The native planters are endeavouring to improve their methods and output, and sugar centrals are being organised which will greatly improve the quality and increase the quantity of production. The restriction imposed by the United States tariff to 300,000 tons allowed to be imported duty free yearly looms, however, largely before those interested in the industry, who live in hopes that this restriction may ultimately be removed.

The labour question, however, still remains a vital one, and this may seriously affect the progress of the industry, scarcity of reliable labour being felt all over the islands.

FORMOSA.

The British Consul's Report for 1910 on the sugar trade is as follows:—

The total production of sugar in 1910 amounted to 4,079,344 cwts. Of this, 3,719,536 cwts. were sent to Japan, 476,190 cwts. being for refining and 3,243,346 cwts. for direct consumption. The quantity exported to foreign countries was 10,426 cwts., this going to Shanghai, Hankow, Dalny and Corea.

The balance, 349,382 cwts., remained in the island to supply the local requirements.

The area of land under sugar cane in 1909 was 68,987 ko (169,018 acres).

In November, 1910, it was announced that no more charters would be granted for the time being for the formation of sugar manufacturing companies, nor for the extension of existing mills, the object being to check the expected over-production of sugar in the island in excess of the demands of Japan for direct consumption and for refining, pending the opening of foreign markets. No period has been fixed for this limitation, which is, however, officially stated to be a temporary measure.

The number of mills, either new mills or extensions of existing ones, opened for the season of 1911 was seven, with a total crushing power of 6,500 tons a day.

By the autumn of 1911, *i.e.*, at the opening of 1912 season, a further nine mills will be completed, with a total crushing power of 7,200 tons a day.

It is estimated that when the new mills now in the course of construction are in full operation the output will be 5,000,000 bags, or double the demand of Japan for direct consumption and for refining.

The export to Japan in 1910 was, however, over 3,000,000 bags.

The proposed alteration in the consumption tax, mentioned in last year's report for South Formosa, came into force on April 1, 1910. A further alteration, given below, came into force in April, 1911:—

	Per 100 Kin or 1 Picul Yen	sen.
Class I, below Dutch Standard II—		
(*a*) Brown sugar in barrels	2	0
(*b*) Unrefined sugar except centrifugalled, or sugar other than unrefined which has been manipulated, or sugar made partially or entirely by modern machinery..	2	50
(*c*) All others	3	0

The average price of centrifugalled sugar sold to refiners in 1910 was 14s. per picul.

The present subsidies on sugar are 1 yen per 1000 kin of cane cut and 1 yen 95 sen per 100 kin (1 picul) of sugar sent to Japan for refining. This subsidy was limited to 1,000,000 piculs, but 1 yen per picul is to be allowed on any excess above this quantity.

The subsidy for the year 1910-11 is estimated at 2,830,000 yen (£288,896).

It is now proposed to abolish those subsidies from April, 1912, on the ground that the new customs tariff which came into force in July, 1911, will give sufficient protection against the competition of foreign sugar. No decision has yet been announced, however.

The sum provided for the sugar subsidy in the Budget for 1911-12 is 2,640,000 yen (£269,500).

The production of sugar for the present season, 1911, is estimated at from 410,000,000 to 430,000,000 kin (5,119,000 cwts.), being from 310,000,000 to 330,000,000 ken (3,929,000 cwts.) of centrifugal and 100,000,000 kin (1,190,000 cwts) of brown sugar.

Up to December last contracts had been made in Japan for the sale of 2,100,000 bags (100 kin each); of this, 1,100,000 bags were for direct consumption, the rest for refining. This amount, with 250,000 bags sold for export and 250,000 bags appropriated for the manufacture in Formosa of white crystallized and white moist sugar, leaves a balance, on the lower estimate, of 500,000 bags of centrifugal sugar, which the Formosan sugar mills asked three of the large sugar refining companies of Japan to take over. They agreed on condition that the Formosan companies should refrain from producing white sugar and from exporting crude sugar abroad. This condition the mills refused to accept, having completed their arrangements for producing white sugar. Eventually the refiners agreed to take the 500,000 bags on the Formosan mills agreeing to reduce the export of white crystallized sugar to Japan. The mills having further undertaken not to export to Japan more than 1,100,000 bags for direct consumption, the associated sugar merchants, with one exception, agreed in return not to import foreign sugar.

The area of land under sugar cane in 1910 was 90,005 ko (220,512 acres), an increase of 51,494 acres over 1909.

Two mills in Formosa proposed to start the manufacture of white moist sugar this season by the sulphide bleaching process, but have given way before the protest raised by the sugar refiners in Japan, who feared the competition of white sugar with their refined sugar. The execution of this project has been postponed, but it is probable that some Formosan sugar mills will in the near future make white sugar directly from the cane by this chemical process, thereby saving the freight on crude sugar sent to Japan for refining. It is said, however, that this process involves a greater loss in weight and that the resultant sugar is of somewhat inferior colour, which also deteriorates with keeping. It will, therefore, not prove a very strong rival to that refined by the charcoal method, except as a cheaper substitute. It will probably be manufactured for export to China and Corea.

One Formosan company has just purchased the works of the Kobe Sugar Refining Company (capital, £200,000, £75,000 paid up), and it is reported that

a syndicate of Formosan companies are about to purchase the Yokohama Sugar Refining Company's works. They will then be in a position to refine the product of their own mills, and will no longer be under the necessity of coming to terms with the refiners in Japan with regard to dealing with the product of their mills.

A mill is also being erected near Taihoku with the intention of manufacturing refined sugar. It will have the advantage over the southern mills of a plentiful supply of good water and cheap fuel (coal). Refining will be done in the summer after the crushing has been finished.

The Bank of Formosa in April, 1911, opened a branch at Shanghai, and an associated sales market has been established there by dealers in Formosan sugar.

The abolition of the Formosan export duties in November, 1910, is ascribed to the agitation of sugar manufacturers, who are now looking for foreign markets for Formosan sugar, which has not hitherto been exported in any quantity. The duty per 100 kin (133 lbs.) was 45 sen (11d.) on brown sugar and 56 sen (1s. $1\frac{3}{4}$d.) on white.

A shipment of 1,000 tons of brown sugar was made from Takow in April, 1911, to a refinery at Vancouver.

Correspondence.

SUGAR STATISTICS.

To the Editor of the "International Sugar Journal."

Sir,—The wide circulation of your valuable journal appears to me to make it a good medium through which to make a simple, but important suggestion, viz. :—

That your influential readers should urge the newspapers to print the Board of Trade Import and Export figures monthly, half-yearly and yearly, *in quantity*, as well as sterling. The latter is most misleading (especially in times like the present, with the highest record prices) while the former cannot lie.

Of course, the *Board of Trade Journal* shows both (except that quantities are given in cwts. where tons would be simpler) but many business men seldom see it, and the general public never.

Yours truly,

C. A. Bean.

Liverpool, 7th November, 1911.

[**** It must be observed that the *Times* at any rate has for a long time been in the habit of publishing the quantities as well as values; but there are doubtless other daily journals that leave much to be desired in the way they handle the figures. But even the Board of Trade figures, as we have already had occasion to point out, and as our correspondent himself admits, are unsatisfactory, inasmuch as they are given in *cwts.* instead of the more generally quoted *tons.*]—(Ed. *I.S.J.*)

ABSTRACTS, SCIENTIFIC AND TECHNICAL.*

Cleaning the Steam Chamber of an Evaporator with Benzine. *By A. Franken. Archief, 1911, 19, 1224-1225.*

As several writers have pointed out, a troublesome deposit of greasy non-conducting substance, derived largely from the steam used, may occur in the steam chamber of the first vessel of the multiple effect, retarding the transmission of heat, and consequently diminishing the efficiency of the apparatus.† In order to remove this caked, oily layer, benzine is the best solvent; and according to the author's experience the most efficient and economical procedure of using it is as follows: Directly after the termination of the campaign, the triple effect is cleaned thoroughly and repaired. In the top tube plate, an opening 1½-2 in. in diam., capable of being closed by a locked screw cap, is made; but if there is no space in which to make an extra hole, then one of the tubes is taken out. It is of importance that before the treatment with benzine is begun, the triple should be in good condition, and that the shut-off valves opening into the steam chamber should not leak, but close quite tightly. After this, the ammonia pipe is broken by a flange joint, as close as possible to the next vessel, and the section of the pipe near the steam chamber closed by a ½in. cock, the same thing being also done in the case of the condensed water pipe. By means of the 1½-2in. opening in the top tube plate, the steam chamber is filled with water. Then from the ½in. cock in the condensed water pipe, about three kerosene‡ tins of water are drawn off; and this volume replaced through the 1½-2in. opening by benzine, pouring the solvent in as slowly and carefully as possible, so that it remains on the surface of the water. Thus in the steam chamber there is a column of water, and above it a layer of benzine. After tightly packing and closing the 1½-2in. opening in the top tube plate, the ½in. cock in the condenser water pipe is opened; but only to such an extent that the steam chamber will be emptied at the end of two months. It is clear that in this way the column of benzine will gradually descend, touching all parts of the heating surface, and dissolving all the adhering oily particles from it. Naturally, the greater the amount of oily matter present in the steam chamber, and the larger the heating surface, the more benzine must be employed. As advantages of this procedure, it is pointed out that: (1) the cost of the benzine required is small; and (2) the only supervision is to see each day that the amount of water dropping out is not too great. This latter, however, is readily ensured if the volume of liquid in the steam chamber be known, and the amount dropping out daily be determined.

---

† In his book "Cane Sugar and its Manufacture," Prinsen Geerligs shows that such deposits consist principally of oil, iron oxide, and copper oxide, small amounts of lead oxide and graphite being also present.—(Ed. *I.S.J.*)

‡ Altogether about 15 gallons.—(Ed. *I.S.J.*)

ENTRAINMENT IN MULTIPLE EFFECT EVAPORATORS. *By E. W. Kerr. Modern S. Planter, 1911, 42, No. 6, 2-4.*

As is well known, entrainment is the carrying forward of juice in the form of drops and bubbles by the more or less rapid current of vapour which accompanies ebullition. In a multiple effect, the vapour from the first body carries juice over to the calandria of the second body where the vapour is condensed, the result being that the condensation water is sweet. The vapour and sugar entrained in the second body likewise causes sweet-water in the calandria of the third vessel; and so on, each succeeding vessel containing more sugar in the condensate. The sugar thus entrained has a harmful effect, not only owing to the loss of sugar, but also on account of the corrosive action of the sweet-water when used in the boilers.* For this reason it is often considered inadvisable to use this water, especially that from the last body, in the boilers. The greatest loss seems to be in the hollow drops or bubbles, which are so light that it is difficult to stop them, the slightest current being able to carry them along. The formation of hollow drops, especially, is facilitated by increased viscosity of the liquid due to the solid matter in solution. In other words, the liquid with solids in it is more likely to form bubbles than pure water. We have an example of this in the case of soapy water, which forms bubbles much more readily than water without soap in it. This being the case, it may be stated that the formation of bubbles will be greater in the last body of an evaporator than in the first. These bubbles consist of an outer film of liquid with vapour on the inside. Such bubbles are very light, and the slightest current is sufficient to sweep them upward.

From this it is evident that one of the most important factors affecting entrainment is the velocity of the vapour current leaving the boiling surface. The velocity of the vapour current will depend upon the cross sectional area of the vessel, that is, the larger the area the smaller the velocity, and *vice versa*. As a general rule, the cross sectional area of horizontal evaporators is greater than that of standard effects, so that the velocity of the vapours is less in horizontal evaporators than standard evaporators, equal heating surface being considered. For example, we may cite the case of a Wellner-Jelinek horizontal evaporator, the juice space of which is 8 ft. wide and 13 ft. long, the heating surface being the same as that in a 10 ft. standard effect with tubes 4 ft. long. Thus the cross sectional area in the horizontal effect would be $8\times13=104$ sq. ft., while that in the standard effect would be 78·54 sq. ft., thus causing a vapour velocity in the horizontal effect of 78·54 divided by $104=0{\cdot}75$ of that in the standard effect. Then, too, the velocity in the last body of an evaporator is greater than in the first body, due to the greater specific volume of the vapour

* An interesting article by Pillhardt recently appeared dealing with this point (this *Jl.*, 1911, 375).—(Ed. *I.S.J.*)

at the lower pressures. For example, take the case of a triple effect with boiling temperatures in the first, second, and third bodies of 194, 160, and 116° C. respectively. The specific volumes at these temperatures are 37·6, 77, and 227 cub. ft. respectively. Assuming that 6 lbs. of water are evaporated per sq. ft. of heating surface, and that there are $3333\frac{1}{3}$ sq. ft. of heating surface in each body, the velocity of vapour in the first body would be $(3333\frac{1}{3} \times 6 \times 37{\cdot}6) \div (3600 \times 78{\cdot}54) =$ 2·67 ft. per second. In like manner the velocity of the vapour leaving the second body is found to be 5·47 ft. per second, and the third body, 16·15 ft. per second. Thus we have another cause for greater entrainment in the last body than in the others; that is, on account of the much higher velocity, the gravity being too small to over-balance the carrying effect of the rapid vapour current. In a former article it was demonstrated that the capacities of double, triple, or quadruple effects are the same if all bodies contain equal amounts of heating surface; and, further, if other conditions, including initial steam pressure supplied and vacuum in the last body, are equal. This being the case, it is evident that the water evaporated per sq. ft. of heating surface must be greater in the double than in the triple or in the quadruple. Hence, the volume of vapour generated will be less in a quadruple than in a triple or double, the ratios in doubles, triples, and quadruples being as 9: 6: 4·5 respectively. Using the same method of calculation as that given for the triple above, we find that the vapour velocities in the last body of a 10 ft. standard double effect would be 24·22 ft. per second; in the last body of a triple 16·15 ft. per second; and in the last body of a quadruple 12·11 ft. per second. Thus it is clearly shown that the entrainment should be less in a quadruple than in a triple or a double effect.

Another cause of entrainment, closely related to vapour velocity, is the disturbance or upheaval at the surface of the liquid during the boiling process, facilitated in a number of different ways, such as: (1) the evaporator being too small; (2) the tubes being too long; (3) unequal distribution of the steam on the heating surface; and (4) too rapid circulation of the juice in the tubes.

NOTES ON SUGAR HOUSE ANALYSIS. *By W. E. Cross. La. Planter, 1911, 47, 305–306.*

Much time is saved in sugar house work by use of Horne's method of clarification employing solid basic lead acetate, the so-called "dry" process of defecation. From time to time this method has been compared experimentally with the ordinary Schmitz method, and the results have been found to be practically identical. The simplicity of the procedure reduces the experimental error to a minimum, which is also a feature commending to the sugar-house chemist. In the case of a raw or clarified juice, the *modus operandi* is as follows:

About 100 c.c. are poured into a beaker (after taking the Brix value), and the minimum quantity of dry basic lead acetate (lead subacetate), to insure proper defecation, added, the liquid then being filtered and polarized. The percentage of sugar in the juice may then be obtained by reference to the following Table:—

(Sucrose by Horne's Dry Basic Lead Acetate Method.)

Brix Reading (Uncorrected).

Polariscope reading.	10	11	12	13	14	15	16	17	18	Polariscope reading.
36	9·00	8·96	8·92	8·89	8·85	8·82	8·78	8·75	..	36
37	9·25	9·21	9·17	9·14	9·10	9·06	9·03	8·99	..	37
38	9·50	9·46	9·42	9·38	9·35	9·21	9·27	9·23	..	38
39	..	9·71	9·67	9·63	9·59	9·55	9·51	9·48	..	39
40	..	9·96	9·92	9·88	9·84	9·80	9·76	9·72	..	40
41	..	10·21	10·17	10·12	10·08	10·04	10·00	9·96	..	41
42	..	10·46	10·41	10·37	10·33	10·29	10·25	10·21	..	42
43	..	..	10·66	10·62	10·58	10·53	10·49	10·45	..	43
44	..	..	10·91	10·87	10·82	10·78	10·74	10·69	10·65	44
45	..	..	11·16	11·11	11·07	11·03	10·98	10·94	10·89	45
46	..	..	11·41	11·36	11·32	11·27	11·22	11·18	11·13	46
47	..	..	..	11·61	11·56	11·52	11·47	11·42	11·38	47
48	..	..	..	11·86	11·81	11·76	11·71	11·67	11·62	48
49	..	..	..	12·10	12·06	12·01	11·96	11·91	11·86	49
50	..	..	..	12·35	12·30	12·25	12·20	12·15	12·10	50
51	..	..	..	..	12·55	12·50	12·45	12·40	12·35	51
52	..	..	..	..	12·80	12·74	12·69	12·64	12·59	52
53			..	..	13·04	12·99	12·93	12·88	12·83	53
54	Tenths of a division	Sucrose per cent.	..	..	13·29	13·23	13·18	13·13	13·07	54
55			..	..	..	13·48	13·42	13·37	13·32	55
56			..	..	..	13·73	13·67	13·61	13·56	56
57	0·1	0·02	..	..	..	13·97	13·91	13·86	13·80	57
58	0·2	0·05	..	..	..	14·22	14·16	14·10	14·04	58
59	0·3	0·07	..	..	..	..	14·40	14·34	14·29	59
60	0·4	0·10	..	..	..	..	14·65	14·59	14·53	60
61	0·5	0·13	..	..	..	..	14·89	14·83	14·77	61
62	0·6	0·15	..	..	..	..	15·14	15·08	15·01	62
63	0·7	0·17	..	..	..	..	15·38	15·32	15·26	63
64	0·8	0·19	..	..	..	..	..	15·56	15·50	64
65	0·9	0·22	..	..	..	..	..	15·81	15·74	65

In the case of raw sugars and molasses, the procedure adopted by the A.O.A.C. is to make up a normal sugar weight solution in the case of a raw sugar, and a half normal sugar weight solution in the case of a molasses, pour the liquor in a dry beaker, and add sufficient dry basic lead acetate for adequate defecation, finally filtering and polarizing. It is pointed out by the author that whereas in the case of ordinary liquid clarifying agents, such as basic lead acetate solution, the errors due to (*a*) precipitation of levulose, and (*b*) to the volume of the lead precipitate are both in the same direction, with dry basic lead acetate, the errors due to (*a*) precipitation of levulose, and (*b*) the increase in volume owing to the solution of the basic lead acetate, are in opposite directions, and tend to neutralize one another, giving a more accurate result. As to the determination of reducing sugars (glucose), according to the author, no very serious error is introduced by using an unclarified solution in the case of ordinary juices, although when the gums are high, an appreciable amount of reducing substances may be formed by hydrolysis, whilst heating with the Fehling's solution. Indeed, Zerban has shown that slightly higher results for the reducing sugars are obtained with unclarified than with clarified cane juices. Lastly, the author discusses the various methods of determining water in molasses, arranging them in order of their accuracy as follows:—(1) drying on sand *in vacuo*; (2) drying on sand in the steam oven; (3) refractometrically; (4) drying in steam oven without sand; and (5) by means of the Brix spindle. Of these, the first three give results that approximate very closely with one another; but the fourth gives somewhat lower values, while the last, viz., the spindle, gives figures that are usually much lower still. When using the refractometer for solutions of molasses that are too dark to read, dilution should be made, not with water, but with an equal weight of concentrated pure sugar solution, since with water contraction occurs, the water values then being too low.*

RESULTS OF THE EXAMINATION OF SOME COLONIAL SUGARS. *By O. Fallada. Österr.-Ungar. Zeitsch., 1911, 39, 448-458.*

From London the author received a number of samples of cane sugars of which he has made complete analyses. In doing this, the direct polarization was made in a solution clarified with neutral lead acetate, following the instructions given by A. H. Bryan, and using a normal sugar weight solution for the light, and a half normal solution for the dark samples. As a control on the direct polarization thus

* This, of course, was first proposed by Tischtschenko (this *Jl. 1909, 196-198*).—(ED. *I.S.J.*)

made, the normal sugar weight, dissolved in a little water, was treated with neutral lead acetate, some of the new decolorizing carbon, "Eponite" (*cf.* this *Jl.*, 1911, 34, and 496), added, and the whole made up to 100 c.c. By means of a number of experiments with pure sugars, it was ascertained that "Eponite" may be used for this purpose with safety (*cf.* also this *Jl.*, 1911, 36), even in the presence of reducing sugars. All the direct polarizations were made in a jacketed tube at 20°C., and the inversion polarizations were carried out according to the original Herzfeld procedure, using the same tube for this reading as for the direct polarizations. Reducing sugars were estimated on the unclarified solution, after passing it through a filter paper, and from the weight of reduced copper the percentage amount was found by the Meissl-Hiller tables, taking into consideration the amount of sucrose present. Since the water in the samples 1, 2, and 4 was low, desiccation was carried out in the ordinary way at 100-105°C.; but all the other samples were mixed with quartz sand, a little water and a few drops of ammonia added, and finally dried in the vacuum oven at 95°C. to constant weight. As to the ash, this was determined as usual by "sulphating," and incinerating at a dull red heat; but the sand present was deducted, and from this sand-free ash, the normal ash was obtained by deducting one-tenth. In addition to the ordinary analytical data, the author also calculated the rotation caused by 100 parts of the reducing sugars present, by Pellet's method, using the values obtained for the reducing sugars and for the sucrose by double polarization. As may be seen from the tabulated results, the rotation of the reducing sugars does not at all correspond to that of invert sugar, which according to the Herzfeld inversion method is —32·66, but varies within the wide limits of —1·5 to —57·0°V. It is seen that in the samples 1, 5, and 7, levulose predominates; whilst in the others, as is generally the case, dextrose is in excess. As a further proof that the reducing sugars present in cane sugars are not a mixture of equal parts of dextrose and levoluse, the "theoretical polarization" was calculated in each case, by adding 0·34 times the percentage of reducing sugars to the direct polarization, differences between this theoretical polarization and the sucrose by the double polarization method as high as +2·42 thus being obtained, whereas no difference, or practically none, should be found. Finally the author discusses Wortmann's formula, and its value for indicating the possible presence of raffinose in cane products. It is pointed out that this formula may be used when sucrose, invert sugar, and raffinose are simultaneously present; but emphasizes the fact that it only holds good for invert sugar, and not for a mixture of dextrose and levulose in unequal amounts, such as are found, as a general rule, in cane sugars.

No.	Origin.	Reducing Sugars.	Water.	Ash.	Direct Polarization.	Inversion Polarization at 20° C.	Sugar by Clerget (Double Polarization).	Difference between direct Polarization and Clerget.	Rotation of 100 Parts of the Reducing Sugars present.	"Theoretical Polarization."	Differences between Sugar by Clerget and the "theoretical" Polarization.
1	Java	0·93	0·34	0·30	97·65	—32·60	98·18	—0·53	—57·0	97·97	—0·21
2	Brazil	2·46	1·75	1·20	92·15	—30·20	92·22	—0·08	— 3·3	92·99	+0·76
3	Jamaica	1·31	2·75	2·17	91·30	—30·30	91·66	—0·36	—27·5	91·75	+0·09
4	Demerara	2·88	1·95	1·52	91·25	—30·00	91·39	—0·14	— 4·9	92·23	+0·84
5	Jamaica	1·30	2·38	2·50	90·65	—30·20	91·10	—0·45	—34·6	91·09	—0·01
6	Guatemala	1·97	2·30	2·77	89·40	—29·50	89·63	—0·23	—11·7	90·07	+0·44
7	Mauritius.. ..	3·61	3·22	3·71	84·35	—29·20	85·59	—1·24	—34·3	85·58	—0·01
8	Manila	8·18	3·43	1·90	81·80	—29·20	83·67	—1·87	—22·9	84·58	+0·91
9	{Guatemala .. / Panela ....}	7·81	6·34	2·49	78·00	—27·20	79·30	—1·30	—16·6	80·66	+1·36
10	Manila	9·99	5·78	3·11	77·80	—27·40	79·30	—1·50	—15·0	81·20	+1·90
11	Java..	7·54	5·17	4·04	77·05	—26·50	78·06	—1·01	—13·4	79·61	+1·55
12	Trinidad	7·46	5·32	4·49	76·40	—25·10	76·51	—0·11	— 1·5	78·93	+2·42
13	Ilo-Ilo	11·23	6·02	2·38	75·25	—27·20	77·23	—1·98	—17·6	79·07	+1·76
14	{Venezuela .. / Panela.. ..}	10·30	7·51	4·40	74·95	—28·30	77·83	—2·88	—28·0	78·45	+0·62
15	Jaggery	7·46	7·04	4·31	72·40	—26·80	74·78	—2·38	—23·3	75·82	+1·04
16	Penang	13·82	8·19	2·89	68·65	—26·00	70·89	—2·84	—20·6	72·75	+1·86

Analyses of Incrustations, Scum, Defecation Lime, Sulphur, and Ultramarine. *By J. J. Hazewinkel. Archief, 1911, 19, 1485-1493.*

In the annual report of the Experiment Station at Pekalongan a number of interesting analyses are given, which are briefly summarized in this article. *Incrustation from a sulphur oven pipe.* This was taken from the portion of the pipe close to the thick-juice sulphiters, and had the following composition: free, sublimed sulphur, 11·92; organic matter, 5·29; sulphuric acid, 23·09; ferrous oxide, 22·55; silica, 0·98; water, 32·90; lime, magnesia, oxygen of the oxides, &c., 3·27 per cent. It is thus seen that this scale is the result of the action of the free sulphurous acid upon the metal of the pipe. *Incrustation from a vacuum pan.* As taken from the dome of a pan, the substance had the following composition: water, 3·24; loss on ignition, 10·48; insoluble in hydrochloric acid, 5·76; oxides of iron and alumina, 80·00; sulphuric acid, 0·80; and make up, 0·28 per cent. While a deposit found in the steam chamber of the second and third vessels respectively gave the following results: water, 9·48, 2·22; silica, 0·40, absent; insoluble in hydrochloric acid, absent, 2·12; cupric sulphate, 29·88, 34·92; cuprous oxide, 50·51, 57·06; organic matter, &c., 9·73, 3·68 per cent. In both cases the figures obtained point to marked corrosion on the part of the sulphurous acid. *Centrifugal scum.* From the interior partition of the drum of a centrifugal, a deposit, or "scum," showing the following figures on analysis, was removed: water, 1·86; loss on ignition, 38·22; insoluble in acid, 2·96; silica, 1·10; iron and aluminium oxides, and possibly also phosphoric acid, 13·70; sulphuric acid, 23·60; lime, 17·64; magnesia, absent; copper, traces; and lead, also traces. At first sight, the composition of these substances was peculiar, but a determination of the gum content made the matter clear. According to Maxwell's theory, gum may occur in the juice combined to sulphates, so that the scum would then contain 55 per cent. of the gum complex (17·64 + 23·60 + 15·62), the rest being insoluble matter from the juice. During boiling, this compound had become deposited upon the crystal, hence its behaviour in the centrifugals. *Defecation Lime.* In evidence of the fact that badly made lime is still put on the market, the following analysis is given: water, 4·12; carbon dioxide, 3·09; insoluble in hydrochloric acid, 0·30; silica, 1·50; oxides of iron and alumina, 1·00; calcium oxide, 89·15; magnesium oxide, 1·15; alkalis, 0·21 per cent. The sample slaked very badly, by reason of its high carbonate content, and the amount of water in it is much too high. *Sulphur.* A sample of material coming from India gave satisfactory figures: water, 0·10; ash, 0·10; and sulphur, determined directly by solution in carbon bisulphide, 99·80 per cent. It is proposed to use this sulphur for making sulphurous acid in Javan factories. *Ultramarine.* Two samples

of ultramarine were examined, and at the same time compared with analyses of material known to be of good quality, quoted by Tervooren in his standard book:*

	I. Ultra-marine.	II. Ultra-marine (Tervooren).	III. Ultra-marine.	IV. Ultra-marine (Tervooren).
Colour	blue	blue	violet	violet
Silica	41·90	39·88	39·60	40·55
Alumina	25·40	27·84	27·00	26·90
Sodium oxide	18·11	17·97	18·91	16·30
Lime	0·49	—	—	0·50
Sulphur as sulphate	0·05	—	—	—
,, ,, sulphide	1·50	2·45	0·99	1·84
,, ,, polysulphide	10·70	10·75	12·37	11·70
,, ,, sulphuric acid	—	—	0·32	0·71
Water	1·50	0·80	0·73	0·94
Undetermined	0·35	0·31	0·08	0·57
	100·00	100·00	100·00	100·00
Sulphuretted hydrogen distilled off, per 100 grms.	10·5	—	14·5	—

It is thus seen none of the samples differed much from one another. Both colour and fineness were very good.

NOTE ON THE DETERMINATION OF GLUCOSE IN CANE JUICES. *By W. E. Cross. La. Planter, 1911, 47, 272.*

It is pointed out by the writer that in the volumetric determination of glucose in juices much time may be saved if the juice be measured instead of weighed, and that if the operation is performed carefully with properly standardized pipettes, etc., great accuracy is attainable. The procedure is exactly the same as with the ordinary method, except that so many cubic centimetres, instead of so many grams of the juice are taken and made up to 200 c.c. The result is calculated out exactly as if so many grams had been used, and the percentage of glucose is obtained from Table 1:—

* *Methoden van onderzoek bij de Java Rietsuiker-industrie*, 3rd ed., page 289 *et seq.*

TABLE 1.

Giving the Correct Percentage of Glucose with different Brix Values.

Glucose found per cent.	BRIX (uncorrected). 10	11	12	13	14	15	16	17	18	19	20
0·5	0·48	0·48	0·47	0·47	0·47	0·47	0·47	0·47	0·47	0·46	0·46
0·6	0·58	0·57	0·57	0·57	0·57	0·56	0·56	0·56	0·56	0·56	0·55
0·7	0·67	0·67	0·67	0·66	0·66	0·66	0·66	0·65	0·65	0·65	0·65
0·8	0·77	0·77	0·76	0·76	0·76	0·75	0·75	0·75	0·74	0·74	0·74
0·9	0·86	0·86	0·86	0·85	0·85	0·85	0·85	0·84	0·84	0·83	0·83
1·0	0·96	0·96	0·95	0·95	0·95	0·94	0·94	0·93	0·93	0·93	0·92
1·1	1·06	1·05	1·05	1·04	1·04	1·03	1·03	1·03	1·02	1·02	1·01
1·2	1·15	1·15	1·14	1·14	1·13	1·13	1·13	1·12	1·12	1·11	1·11
1·3	1·24	1·24	1·24	1·23	1·23	1·22	1·22	1·21	1·21	1·20	1·20
1·4	1·34	1·33	1·33	1·33	1·32	1·32	1·31	1·31	1·30	1·30	1·29
1·5	1·44	1·44	1·43	1·42	1·42	1·41	1·41	1·40	1·40	1·39	1·38
1·6	1·54	1·53	1·52	1·52	1·51	1·50	1·50	1·50	1·49	1·49	1·48
1·7	1·63	1·63	1·62	1·61	1·61	1·60	1·60	1·59	1·58	1·58	1·57
1·8	1·72	1·72	1·72	1·71	1·70	1·69	1·69	1·68	1·68	1·67	1·66
1·9	1·82	1·82	1·81	1·80	1·80	1·79	1·79	1·78	1·77	1·76	1·75
2·0	1·92	1·91	1·91	1·90	1·89	1·88	1·88	1·87	1·86	1·86	1·85
2·1	2·02	2·01	2·00	1·99	1·99	1·97	1·97	1·96	1·96	1·95	1·95
2·2	2·11	2·10	2·10	2·09	2·08	2·07	2·07	2·05	2·05	2·04	2·03
2·3	2·21	2·20	2·19	2·18	2·17	2·16	2·16	2·14	2·14	2·13	2·12
2·4	2·30	2·30	2·29	2·28	2·27	2·26	2·25	2·24	2·23	2·22	2·22
2·5	2·40	2·39	2·38	2·38	2·37	2·36	2·35	2·33	2·32	2·31	2·30

To take an example, 50 c.c. juice are measured by means of a pipette, into a 200 c.c. flask, which is then filled up to the mark with water. In the titration against 10 c.c. of Fehling's solution, 22·2 c.c. of the juice solution were found to be necessary. By the ordinary calculation, this corresponds to 0·9 per cent. of glucose. Since 50 c.c. and not 50 grms. were used, the correct value must be found from the table. Suppose the juice was 17° Brix., then the percentage of glucose would be 0·84. The Spencer pipette may also be used to advantage for rapid glucose determinations. The standardized pipette is filled up with juice to the reading corresponding to the Brix value, and this volume is run into a 250 c.c. flask, which is then completed to the mark with water. This juice solution is used for the usual titration, and from the number of c.c. necessary for the reduction of

10 c.c. of Fehling's solution, the percentage of glucose is obtained by reference to Table 2:—

TABLE 2.

Giving the Percentage of Glucose when the contents of the Spencer Pipette are made up to 250 c.c., and the liquid is titrated against 10 c.c. of Fehling's Solution.

Solution required, c.c.	0·0	0·1	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9
12	2·00	1·98	1·96	1·95	1·94	1·92	1·90	1·89	1·88	1·86
13	1·85	1·83	1·81	1·80	1·79	1·78	1·76	1·75	1·74	1·73
14	1·71	1·70	1·69	1·68	1·66	1·65	1·64	1·63	1·62	1·61
15	1·60	1·59	1·58	1·57	1·56	1·55	1·54	1·53	1·51	1·51
16	1·50	1·49	1·48	1·47	1·46	1·45	1·44	1·44	1·42	1·41
17	1·41	1·40	1·39	1·39	1·38	1·36	1·36	1·35	1·34	1·33
18	1·33	1·32	1·31	1·31	1·30	1·30	1·29	1·29	1·28	1·27
19	1·26	1·25	1·25	1·24	1·24	1·23	1·22	1·21	1·21	1·20
20	1·20	1·19	1·19	1·18	1·18	1·17	1·16	1·16	1·15	1·15
21	1·14	1·14	1·13	1·12	1·12	1·11	1·11	1·10	1·10	1·10
22	1·09	1·09	1·08	1·08	1·07	1·07	1·06	1·06	1·05	1·05
23	1·04	1·04	1·04	1·03	1·02	1·02	1·02	1·01	1·01	1·00
24	1·00	1·00	0·99	0·99	0·99	0·98	0·98	0·97	0·97	0·96
25	0·96	0·96	0·95	0·95	0·94	0·94	0·94	0·93	0·93	0·92
26	0·92	0·92	0·91	0·91	0·91	0·90	0·90	0·90	0·89	0·89
27	0·89	0·89	0·88	0·88	0·88	0·87	0·87	0·87	0·86	0·86
28	0·86	0·85	0·85	0·85	0·84	0·84	0·84	0·83	0·83	0·83
29	0·83	0·82	0·82	0·82	0·82	0·81	0·81	0·81	0·81	0·80
30	0·80	0·80	0·80	0·79	0·79	0·79	0·79	0·78	0·78	0·78
31	0·77	0·77	0·77	0·77	0·76	0·76	0·76	0·75	0·75	0·75

For example, a juice of 15·5° Brix was used, and a Spencer pipette filled to the 15·5° Brix mark with it. This volume was run into a 250 c.c. flask, and the volume completed to the mark with water. On titrating, 18·6 c.c. were necessary, which, on reference to Table 2, are found to correspond to 1·29 per cent.

EFFECT OF DIFFERENT MANURES ON THE FORMATION OF NITRIC NITROGEN IN UPLAND AND LOWLAND SOILS OF THE HAWAIIAN ISLANDS. *By S. S. Peck. Bull. 37, 1911, Agric. and Chem. Series; Expt. Station, Hawaiian Sugar Planters' Assoc.*

In this Bulletin are reported experiments having as their object the study of: (1) the effect of various forms of lime on the formation of

nitric nitrogen in the case of an acid upland soil, from a wet district, which was poor in lime, but rich in organic matter, and of a loose friable texture; and (2) the effect of various fertilizer salts, alone and in combination, on the formation of nitric nitrogen in the case of an alkaline lowland soil, from a district of limited rainfall, which was rich in lime, contained a moderate amount of organic matter, and was of a porous texture. These experiments, carried out in lysimeters, gave the following results: (1) In the instance of the upland soil, additions of calcium oxide, carbonate, and sulphate increased the nitrification of the soil nitrogen, and of the nitrogen added as sulphate of ammonia, and also increased the amounts of lime and potash soluble in water, recoverable in the drainage. It was further observed that the acidity of the soil did not seem to be the controlling factor as regards nitrification, the water-soluble calcium seeming to be of greater importance; and that fertilizing with water-soluble phosphoric acid produced but a slight increase in the nitrification of ammonium sulphate. (2) In the case of the lowland soil, the addition of fertilizers, such as double superphosphate, tricalcic phosphate, and sulphate of potash, increased the amount of nitric nitrogen formed from the soil nitrogen, the best results being obtained in the case of the first two materials. When, however, potash and phosphoric fertilizers together were added, with sulphate of ammonia, a decrease in the amount of nitric nitrogen was observed, which was most marked with the use of double superphosphate. Liming with caustic lime depressed the amount of nitric nitrogen obtained from sulphate of ammonia. It was finally noticed that there was no relationship between the lime in the drainage and the degree of nitrification.

The Island of St. Croix may aptly be described as the garden of the Danish West Indies, owing to its numerous sugar and cotton plantations. These are variously owned, many by British subjects, but principally by two Danish companies, each with extensive steam factories for sugar, which is shipped to Europe and America. The population numbers about 14,000, and consists principally of negro labourers recruited from the British West India Islands.—*(British Consular Report.)*

For the determination of the density of liquid sucrose, a number of investigators have endeavoured to obtain extrapolation results from the curves of aqueous solutions. Now, however, F. Schwers (*Jl. Chem. Soc. Trans.*, 1911, *99*, 1478-1486) has been able to do this directly by taking advantage of the observation that finely pulverised sucrose may be melted under an inert liquid like paraffin without charring. Determinations of the density of liquid sucrose, as compared with water at 4° C., for temperatures between 15 and 115° C. were made, and the value for 14° C. found was 1·51756. The densities of aqueous solutions of sucrose from 10 to 70 per cent. were also ascertained.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I. .E. Chartered Patent Agent, 6, Lord Street, Liverpool; 77, Market Street, Bradford; and 285, High Holborn, London.

GERMAN.—Abridgments.

238670. Stefan von Grabski, of Kruschwitz, Posen. *A diffusion process.* 9th March, 1909. In this process the juice is caused to circulate within the diffuser by means of a pump belonging to each diffuser, and if desired over a separate heating apparatus and also forced from one diffuser to another, and may finally be caused to circulate over a heating body during the charging of one diffuser, an evaporation being produced, if desired, under partial vacuum within the diffuser vessel, with the object of lessening the loss of juice and obtaining a more concentrated and purer juice and thereby relieving the subsequent stations. By this process the evaporation may also be carried out by utilizing heating bodies constructed in the diffuser according to the principle of multiple evaporation, and by placing the evaporating chambers of the respective diffusers under vacuum.

238726. Société Anonyme de la Raffinerie A. Sommier, Paris. *A machine of the kind described in the Patent of Addition No. 238725 for cutting and packing sugar.* (Patent of Addition to Patent of Addition No. 238725 of 7th May, 1910.) This machine comprises a feeding, cutting, and packing apparatus, in which guide rules for periodically guiding the sugar cubes during the movement of the conveying table are provided on a grating, and are elastically movable relatively to one another, which rules when the grates are inserted one in another are forced away by the sugar cubes from other guide rules on the conveyor table, suitably shaped prolongations of the second series of rules entering grooves in the first named guide rules, whereupon the sugar cubes are carried further by the second series of guide rules.

238727. Société Anonyme de la Raffinerie A. Sommier, Paris. *A machine as set forth in Patent No. 235617 for cutting and packing sugar.* 7th May, 1910. (Patent of Addition to Patent No. 235617 of 27th October, 1909.) This machine consists of feeding, cutting, and packing devices, and is characterized by two slides or pushers having a reciprocating opposing motion, and continuously feeding the sugar blocks to the cutting apparatus, the movement being so regulated that the commencement of the return movement of one slide is delayed as compared with the commencement of the forward movement of the other slide.

238946. Georg Schimeiser, of Magdeburg. *A two roller drying apparatus, the stirrers of which are located above between the rollers, are formed of straight bars running axially to the rollers, and extend over the*

entire length of the rollers, and are moved to and fro by means of rocking le s. 17th July, 1910. The characteristic feature of this apparatus is that the bars of the stirring or agitating mechanism lie tangentially to the surface of the rollers.

239059. FERDINAND LAFEUILLE, of Charmes, France. *A drying drum apparatus, more particularly for sugar beet, potatoes, and like substances, consisting of an external revoluble drum and an inner straining drum.* 24th September, 1910. This apparatus is characterized by the straining drum being divided by partitions in its lower part, which are capable of being firmly connected with lateral semi-cylinders filling up the lower half of the drum, and are mounted on a central shaft. In another form of construction of the apparatus flaps are arranged on a central pipe, each flap being independently adjustable by means of drawbars arranged in the pipe, and capable of being fixed in a given position. A further feature of the apparatus is that the first or the first fixed partitions form conical elliptical half troughs, and the circular pipe for the admission of the gas is connected with the following suspended tubular parts.

239405. Dr. OTTO PANKRATH, of Frankfort-on-Main. *A periodically automatically discharged centrifugal, more particularly for sugar massecuite.* 27th April, 1909. This centrifugal comprises several conical compartments, which widen out in the direction of the centrifugalling, which are each provided with separate closing devices which are opened and closed successively, in order to allow of the centrifugal being continuously fed.

238949. FIRM H. EBERHARDT MASCHINEN-UND ARMATUREN-FABRIK, of Wolfenbüttel. *Crystallizer, more particularly for sugar massecuite.* 2nd June, 1909. In this crystallizer, more particularly for sugar massecuite mixed with commencing crystals, and adapted to be revolved about a horizontal transverse axis, there is an agitating mechanism mounted on a shaft lying at right angles to the axis of rotation and guided therein, which mechanism is periodically set in rotation when the crystallizer is rocked, with the object of preventing the crystalline substance from adhering to the walls of the crystallizer.

UNITED KINGDOM.

IMPORTS AND EXPORTS OF SUGAR

To End of November, 1910 and 1911.

IMPORTS.

Unrefined Sugars.	1910. Tons.*	1911. Tons.*	1910. £	1911. £
Russia	93	1,749	1,190	21,686
Germany	166,605	393,386	2,034,951	4,304,003
Netherlands	18,688	28,206	220,101	431,235
Belgium	10,763	19,750	125,325	261,906
France	431	245	6,260	2,383
Austria-Hungary	47,121	49,915	611,604	562,832
Java	118,204	161,513	1,603,911	2,618,885
Philippine Islands	....	3,485	....	30,829
Cuba	96,336	3,859	1,371,633	29,610
Dutch Guiana	6,355	5,414	92,725	72,093
Hayti and San Domingo	76,547	28,047	1,078,592	305,875
Mexico	10,640	8,117	150,962	101,592
Peru	44,452	23,847	571,146	246,395
Brazil	51,354	13,704	617,901	126,369
Mauritius	39,535	51,049	570,579	570,136
British India	8,871	25,912	96,674	436,209
Straits Settlements	792	1,083	9,389	14,417
Br. West Indian Islands, Br. Guiana & Br. Honduras	74,812	51,578	1,090,285	700,964
Other Countries	24,062	16,670	319,849	188,765
Total Raw Sugars	795,662	887,531	10,573,077	11,026,181
Refined Sugars.				
Russia	173	98,437	2,572	1,488,331
Germany	290,878	343,890	4,511,432	4,877,796
Holland	100,879	130,617	1,582,753	2,118,829
Belgium	39,982	52,812	622,439	885,863
France	60,089	5,315	995,532	82,297
Austria-Hungary	168,358	169,327	2,698,688	2,412,821
Other Countries	80,548	45,169	1,366,797	783,143
Total Refined Sugars	740,908	845,567	11,780,213	12,649,080
Molasses	138,796	139,693	633,903	595,864
Total Imports	1,675,366	1,872,791	22,987,193	24,271,128

EXPORTS.

British Refined Sugars.	Tons.	Tons.	£	£
Denmark	3,683	3,917	52,084	49,424
Netherlands	3,019	2,650	44,850	38,594
Portugal, Azores, & Madeira	1,526	1,006	22,195	13,608
Italy	605	1,060	7,884	12,762
Canada	10,266	8,504	163,283	127,441
Other Countries	9,136	9,949	166,101	168,713
	28,236	27,086	456,397	410,542
Foreign & Colonial Sugars				
Refined and Candy	765	1,147	14,031	18,305
Unrefined	5,782	6,818	77,366	87,358
Various Mixed in Bond	75	....	1,285	....
Molasses	305	361	2,143	2,381
Total Exports	35,163	35,412	551,222	518,586

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1911. Tons.	1910. Tons.
Total Receipts Jan. 1st to Nov. 29th	2,065,235	2,088,350
Receipts of Refined ,, ,,	231	149
Deliveries ,, ,,	2,052,695	2,088,143
Importers' Stocks, November 29th	12,540	3,557
Total Stocks, December 6th	134,000	88,740
Stocks in Cuba, ,,	—	—
	1910.	1909.
Total Consumption for twelve months	3,350,355	3,257,660

CUBA.

Statement of Exports and Stocks of Sugar for 1909, 1910 and 1911.

(Tons of 2,240 lbs.)	1909. Tons.	1910. Tons.	1911. Tons.
Exports	1,407,995	1,692,216	1,408,812
Stocks	24,063	54,376	6,040
	1,432,058	1,746,592	1,414,852
Local Consumption (9 months)	46,970	46,008	51,850
	1,479,028	1,792,600	1,466,702
Stock on 1st January (old crop)	....	....	....
Receipts at Ports up to Sept. 30th	1,479,028	1,792,600	1,466,70

Havana, 30th September, 1911. J. Guma.—F. Mejer.

UNITED KINGDOM.

Statement of Imports, Exports, and Consumption of Sugar for Eleven Months ending November 30th, 1909, 1910, 1911.

	Imports.			Exports (Foreign).		
	1909. Tons.	1910. Tons.	1911. Tons.	1909. Tons.	1910. Tons.	1911. Tons.
Refined	851,681	740,908	845,567	693	765	1,147
Raw	725,438	795,662	887,531	3,136	5,857	6,818
Molasses	145,849	138,796	139,693	278	305	361
	1,722,968	1,675,366	1,872,791	4,107	6,927	8,326

	Home Consumption.		
	1909. Tons.	1910. Tons.	1911. Tons.
Refined	838,935	731,323	803,861
Refined (in Bond) in the United Kingdom	557,150	588,185	606,083
Raw	105,958	135,717	121,197
Molasses	132,242	133,377	133,830
Molasses, manufactured (in Bond) in U.K.	62,102	61,401	74,310
Total	1,696,387	1,650,003	1,739,311
Less Exports of British Refined	30,648	28,236	27,086
	1,665,739	1,621,767	1,712,225

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, NOVEMBER 1ST TO 30TH, COMPARED WITH PREVIOUS YEARS.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1911.
210,100	453,750	158,760	306,910	125,150	1,254,670

	1910.	1909.	1908.	1907.
Totals ..	..1,684,690..	1,388,610..	1,770,390..	1,664,880.

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING OCTOBER 31ST, IN THOUSANDS OF TONS.

(Licht's Circular.)

Great Britain.	Germany.	France.	Austria-Hungary	Holland, Belgium, &c.	Total 1910-11.	Total 1909-10.	Total 1908-09.
2016	1402	793	676	247	5133	4687	4632

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1911-1912. Tons.	1910-1911. Tons.	1909-1910. Tons.	1908-1909 Tons.
Germany	1,350,000 ..	2,600,000 ..	2,033,834 ..	2,082,848
Austria	1,150,000 ..	1,538,000 ..	1,256,751 ..	1,398,588
France	550,000 ..	720,000 ..	806,405 ..	807,059
Russia	2,000,000 ..	1,140,000 ..	1,126,853 ..	1,257,387
Belgium	235,000 ..	285,000 ..	249,612 ..	258,339
Holland	255,000 ..	222,000 ..	198,456 ..	214,344
Other Countries .	510,000 ..	590,000 ..	465,000 ..	525,300
	6,050,000	8,095,000	6,136,911	6,543,865